MADISON COUNTY
INDIANA

STORMWATER

TECHNICAL STANDARDS MANUAL

Provided By: MADISON COUNTY DRAINAGE BOARD
With assistance from:

The Indiana LTAP Stormwater Drainage Manual
The Indiana Drainage Handbook
The Indiana Handbook for Erosion Control in Developing Areas

Introduction

This Document is a companion document to the Madison County Drainage Ordinance.

This document contains the design standards and requirements of Madison County for all real property and/or land alterations within the jurisdiction of Madison County and specifically the Madison County Drainage Board. This document is to be used in conjunction with the Madison County Drainage Ordinance as a guide to assist land owners, plan designers, engineers, architects, land surveyors, developers, contractors, reviewers, and others in complying with said ordinance.

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Chapter One

METHODOLOGY FOR DETERMINATION OF RUNOFF RATES

Runoff rates shall be computed for the area of the parcel under development plus the area of the watershed flowing into the parcel under development. The rate of runoff which is generated as the result of a given rainfall intensity may be calculated as follows:

A. Development sites less than or equal to 5 acres in size, with a contributing drainage area less than or equal to 50 acres and no depressional storage.

The Rational Method may be used. A computer model, such as Win TR-55 or Win TR-20 Watershed Hydrology may also be used to generate hydrographs based on the data from the 24-hour NOAA Atlas 14 Storm Event. In the Rational Method, the peak rate of runoff, Q, in cubic feet per second (cfs) is computed as:

$$Q = C I A$$

Where:

C = Runoff coefficient, representing the characteristics of the drainage area and defined as the ratio of runoff to rainfall.

I = Average intensity of rainfall in inches per hour for a duration equal to the time of concentration (tc) for a selected rainfall frequency.

A = Tributary drainage area in acres.

Values for the runoff coefficient "c" are provided in Tables 1-1 and 1-2, which show values for different types of surfaces and local soil characteristics. The composite "c" value used for a given drainage area with various surface types shall be the weighted average value for the total area calculated from a breakdown of individual areas having different surface types. Table 1-3 provides runoff coefficients and inlet times for different land use classifications.

Rainfall intensity shall be determined from the rainfall frequency data shown in Table 1-4.

In general, the time of concentration (t_C) methodology to be used for all stormwater management projects within Madison County shall be as outlined in the U.S. Department of Agriculture (USDA)-NRCS TR-55 Manual. In urban or developed areas, the methodology to be used shall be the sum of the inlet time and flow time in the stormwater facility from the most remote part of the drainage area to the point under consideration. The flow time in the storm sewers may be estimated by the distance in feet divided by velocity of flow in feet per second. The velocity shall be determined by Manning's Equation (see Chapter 3).

Inlet time is the combined time required for the runoff to reach the inlet of the storm sewer. It includes overland flow time and flow time through established surface drainage channels such as swales, ditches, and sheet flow across such areas as lawns, fields, and other graded surfaces.

TABLE 1-1

URBAN RUNOFF COEFFICIENTS

Type of Surface	Runoff Coefficient "C"
Hard Surfaces	
Asphalt	0.82
Concrete	0.85
Roof	0.85
Lawns (Sandy)	
Flat (0-2% Slope)	0.07
Rolling (2-7% Slope)	0.12
Steep (Greater than 7% Slope)	0.17
Lawns (Clay)	
Flat (0-2% Slope)	0.16
Rolling (2-7% Slope)	0.21
Steep (Greater than 7% Slope)	0.30

Source: HERPICC Stormwater Drainage Manual. July 1995.

TABLE 1-2

RURAL RUNOFF COEFFICIENTS

Type of Surface	Runoff Coefficient "C"
Woodland (Sandy)	
Flat (0-5% Slope)	0.10
Rolling (5-10% Slope)	0.25
Steep (Greater than 10% Slope)	0.30

Type of Surface	Runoff Coefficient "C"
Woodland (Clay)	
Flat (0-5% Slope)	0.30
Rolling (5-10% Slope)	0.35
Steep (Greater than 10% Slope)	0.50
Pasture (Sandy)	
Flat (0-5% Slope)	0.10
Rolling (5-10% Slope)	0.16
Steep (Greater than 10% Slope)	0.22
Pasture (Clay)	
Flat (0-5% Slope)	0.30
Rolling (5-10% Slope)	0.36
Steep (Greater than 10% Slope)	0.42
Cultivated (Sandy)	
Flat (0-5% Slope)	0.30
Rolling (5-10% Slope)	0.40
Steep (Greater than 10% Slope)	0.52
Cultivated (Clay)	
Flat (0-5% Slope)	0.50
Rolling (5-10% Slope)	0.60
Steep (Greater than 10% Slope)	0.72

Source: HERPICC Stormwater Drainage Manual, July 1995.

TABLE 1-3

Runoff Coefficients "C"
by Land Use and Typical Inlet Times

Land Use	Runoff Coefficients			Inlet Times (Minutes)
	Flat (1)	Rolling (2)	Steep (3)	(4)
Commercial (CBD)	0.75	0.83	0.91	5
Commercial (Neighborhood)	0.54	0.60	0.66	5-10
Industrial	0.63	0.70	0.77	5-10
Garden Apartments	0.54	0.60	0.66	5-10
Churches	0.54	0.60	0.66	5-10
Schools	0.31	0.35	0.39	10-15
Semi Detached Residential	0.45	0.50	0.55	10-15
Detached Residential	0.40	0.45	0.50	10-15
Quarter Acre Lots	0.36	0.40	0.44	10-15
Half Acre Lots	0.31	0.35	0.39	10-15
Park Land	0.18	0.20	0.22	To Be Computed

Source: HERPICC Stormwater Drainage Manual, July 1995.

(1) Flat terrain involves slopes of 0-2%.
(2) Rolling terrain involves slopes of 2-7%.
(3) Steep terrain involves slopes greater than 7%.
(4) Interpolation, extrapolation and adjustment for local conditions shall be based on engineering experience and judgment.

B. Development sites greater than 5 acres in size or contributing drainage area greater than 50 acres or with significant depressional storage.

The runoff rate for these development sites and contributing drainage areas shall be determined by a computer model such as Win TR-55 or Win TR-20 Watershed Hydrology that can generate hydrographs based on the NOAA Atlas 14 Point Precipitation Frequency Estimates for Indiana. 24-hour rainfall depth for various frequencies shall be taken from Table 1-5. The NOAA Atlas 14 distribution ordinates are in Table 1-6. If interconnected ponds are utilized, the use of ICPR or Pond Pack may be required to appropriately model the more complex hydrologic and hydraulic relationships associated with such systems. Other models may be acceptable and must have prior approval by the Madison County Drainage Board prior to their utilization.

TABLE 1-4

Rainfall Intensities for Various Return Periods and Storm Durations

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.384** (0.353-0.418)	**0.453** (0.416-0.494)	**0.532** (0.488-0.579)	**0.598** (0.548-0.651)	**0.677** (0.616-0.734)	**0.739** (0.669-0.803)	**0.796** (0.717-0.866)	**0.852** (0.763-0.928)	**0.926** (0.820-1.01)	**0.978** (0.861-1.07)
10-min	**0.597** (0.549-0.649)	**0.708** (0.650-0.771)	**0.827** (0.758-0.899)	**0.924** (0.845-1.00)	**1.03** (0.942-1.12)	**1.12** (1.01-1.22)	**1.20** (1.08-1.30)	**1.27** (1.14-1.39)	**1.36** (1.21-1.48)	**1.43** (1.25-1.56)
15-min	**0.732** (0.673-0.796)	**0.865** (0.795-0.943)	**1.01** (0.931-1.10)	**1.14** (1.04-1.24)	**1.28** (1.16-1.39)	**1.39** (1.26-1.51)	**1.49** (1.34-1.62)	**1.58** (1.42-1.72)	**1.70** (1.50-1.85)	**1.78** (1.57-1.95)
30-min	**0.969** (0.890-1.05)	**1.16** (1.06-1.26)	**1.39** (1.27-1.51)	**1.58** (1.45-1.72)	**1.80** (1.64-1.96)	**1.98** (1.79-2.15)	**2.15** (1.94-2.34)	**2.31** (2.07-2.52)	**2.52** (2.23-2.74)	**2.67** (2.35-2.92)
60-min	**1.18** (1.09-1.29)	**1.42** (1.30-1.55)	**1.74** (1.60-1.90)	**2.01** (1.84-2.19)	**2.34** (2.13-2.54)	**2.61** (2.37-2.84)	**2.87** (2.59-3.13)	**3.13** (2.81-3.41)	**3.48** (3.08-3.79)	**3.75** (3.30-4.10)
2-hr	**1.39** (1.29-1.51)	**1.67** (1.54-1.82)	**2.06** (1.90-2.24)	**2.39** (2.19-2.58)	**2.80** (2.56-3.03)	**3.14** (2.86-3.40)	**3.48** (3.14-3.77)	**3.83** (3.42-4.15)	**4.29** (3.80-4.66)	**4.66** (4.09-5.07)
3-hr	**1.48** (1.36-1.61)	**1.77** (1.64-1.93)	**2.19** (2.02-2.38)	**2.54** (2.33-2.75)	**3.00** (2.74-3.25)	**3.38** (3.07-3.66)	**3.77** (3.40-4.08)	**4.17** (3.73-4.52)	**4.71** (4.16-5.12)	**5.15** (4.49-5.61)
6-hr	**1.75** (1.62-1.89)	**2.10** (1.95-2.27)	**2.58** (2.39-2.79)	**2.99** (2.77-3.23)	**3.54** (3.25-3.81)	**4.00** (3.65-4.30)	**4.46** (4.04-4.79)	**4.94** (4.43-5.32)	**5.59** (4.94-6.03)	**6.12** (5.35-6.62)
12-hr	**2.06** (1.91-2.22)	**2.46** (2.29-2.65)	**3.00** (2.79-3.23)	**3.46** (3.21-3.73)	**4.06** (3.74-4.37)	**4.55** (4.17-4.89)	**5.04** (4.59-5.42)	**5.55** (5.01-5.96)	**6.22** (5.54-6.71)	**6.76** (5.97-7.32)
24-hr	**2.37** (2.24-2.52)	**2.85** (2.69-3.03)	**3.49** (3.29-3.71)	**3.99** (3.76-4.24)	**4.67** (4.38-4.95)	**5.20** (4.88-5.51)	**5.74** (5.37-6.08)	**6.29** (5.87-6.66)	**7.03** (6.53-7.43)	**7.60** (7.04-8.04)
2-day	**2.76** (2.60-2.93)	**3.31** (3.12-3.51)	**4.02** (3.79-4.26)	**4.58** (4.32-4.85)	**5.32** (5.01-5.64)	**5.91** (5.54-6.25)	**6.50** (6.08-6.88)	**7.09** (6.62-7.50)	**7.89** (7.32-8.34)	**8.49** (7.86-8.99)
3-day	**2.95** (2.78-3.14)	**3.52** (3.33-3.75)	**4.26** (4.02-4.53)	**4.84** (4.56-5.14)	**5.62** (5.29-5.97)	**6.23** (5.85-6.61)	**6.84** (6.41-7.26)	**7.46** (6.97-7.91)	**8.29** (7.71-8.79)	**8.92** (8.26-9.46)
4-day	**3.14** (2.96-3.34)	**3.74** (3.53-3.98)	**4.51** (4.25-4.80)	**5.11** (4.81-5.43)	**5.92** (5.57-6.30)	**6.56** (6.16-6.96)	**7.19** (6.74-7.64)	**7.84** (7.33-8.32)	**8.69** (8.09-9.23)	**9.35** (8.66-9.93)
7-day	**3.72** (3.52-3.95)	**4.42** (4.17-4.70)	**5.30** (5.01-5.62)	**6.00** (5.66-6.37)	**6.94** (6.53-7.35)	**7.69** (7.22-8.14)	**8.44** (7.90-8.93)	**9.20** (8.59-9.73)	**10.2** (9.50-10.8)	**11.0** (10.2-11.7)
10-day	**4.23** (3.99-4.48)	**5.01** (4.74-5.32)	**5.99** (5.65-6.36)	**6.76** (6.37-7.17)	**7.80** (7.34-8.27)	**8.62** (8.09-9.14)	**9.45** (8.84-10.0)	**10.3** (9.59-10.9)	**11.4** (10.6-12.1)	**12.3** (11.3-13.0)
20-day	**5.79** (5.50-6.10)	**6.84** (6.49-7.21)	**8.06** (7.64-8.49)	**9.01** (8.54-9.49)	**10.3** (9.71-10.8)	**11.3** (10.6-11.8)	**12.2** (11.5-12.9)	**13.2** (12.4-13.9)	**14.4** (13.5-15.2)	**15.4** (14.3-16.2)
30-day	**7.13** (6.78-7.50)	**8.39** (7.98-8.81)	**9.76** (9.27-10.2)	**10.8** (10.3-11.3)	**12.2** (11.5-12.8)	**13.2** (12.5-13.9)	**14.2** (13.4-14.9)	**15.2** (14.3-16.0)	**16.5** (15.5-17.4)	**17.5** (16.3-18.4)
45-day	**9.06** (8.63-9.49)	**10.6** (10.1-11.1)	**12.2** (11.7-12.8)	**13.5** (12.8-14.1)	**15.0** (14.3-15.7)	**16.2** (15.4-17.0)	**17.4** (16.5-18.2)	**18.4** (17.4-19.3)	**19.8** (18.7-20.8)	**20.8** (19.6-21.9)
60-day	**10.8** (10.3-11.3)	**12.6** (12.1-13.2)	**14.4** (13.8-15.1)	**15.8** (15.1-16.5)	**17.6** (16.8-18.4)	**18.9** (18.0-19.8)	**20.2** (19.2-21.1)	**21.4** (20.3-22.4)	**22.9** (21.7-24.0)	**24.0** (22.6-25.1)

Source: NOAA Atlas 14, Volume 2, Version 3 ANDERSON QUARTZ PLANT
Station ID: 12-0177

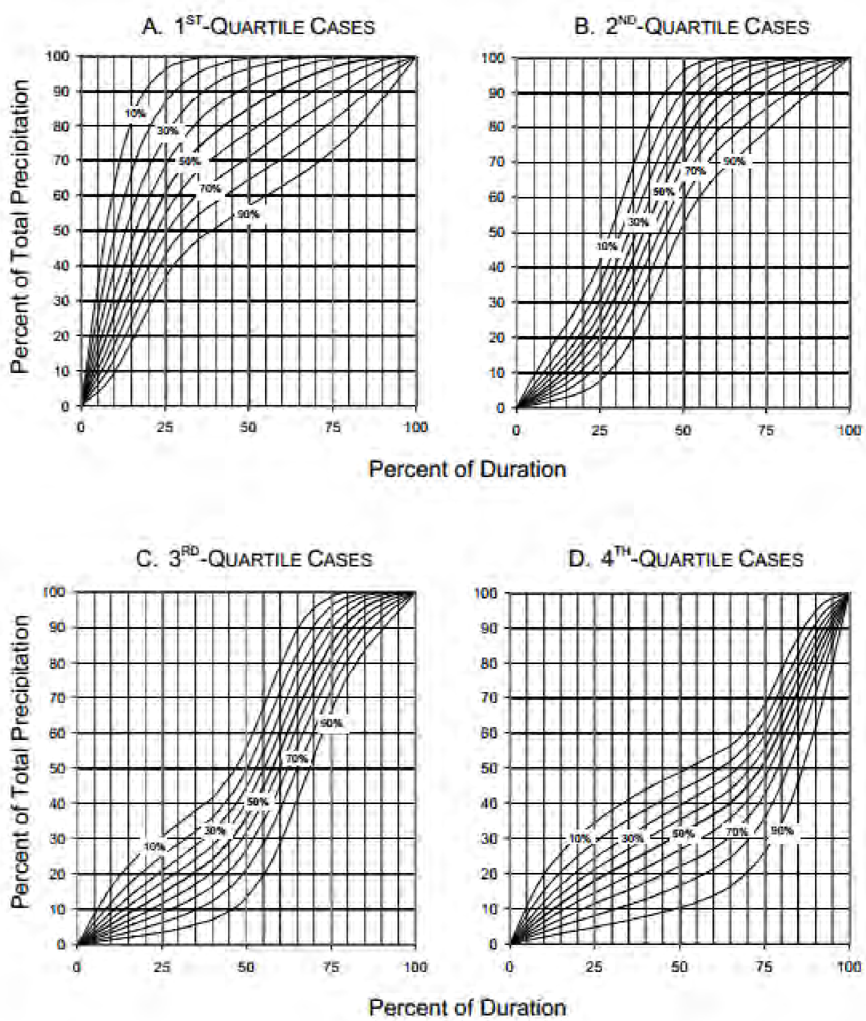
TABLE 1-5
Rainfall Depths for Various Return Periods
Depth (Inches)

Duration	Return Period (Years)					
	2	5	10	25	50	100
24 Hrs.	2.85	3.49	3.99	4.67	5.20	5.74

(Values in this table are based on IDF equation and coefficients provided for Indianapolis, IN.)

TABLE 1-6

TEMPORAL DISTRIBUTION: 24-HOUR DURATION



C. Development sites with drainage areas greater than or equal to one square mile.

The drainage design of any major drainage system, as defined in Appendix A, must be obtained from, or be accepted by, the IDNR. Other portions of the site must use the discharge methodology in the applicable section(s) of these Standards.

D. Methods for calculation of "Time of Concentration" as outlined in the HERPICC Stormwater Drainage Manual, July 1995, may be used by the Designer. The Designer shall state the method selected and used for his/her calculations.

Submittals of calculations for curve numbers and time of concentrations may be required at the discretion of the Madison County Drainage board or their designated representative.

Chapter Two

METHODOLOGY FOR DETERMINATION OF DETENTION STORAGE VOLUMES

A. Development sites less than or equal to 5 acres in size, with a contributing drainage area less than or equal to 50 acres and no depressional storage.

The required volume of stormwater storage may be calculated using the Rational Method and based on the runoff from a 100-year return period storm. A computer model such as Win TR-55 or Win TR-20 Watershed Hydrology that can generate hydrographs based on the NOAA Atlas 14 Point Precipitation Frequency Estimates for Indiana. The computer models ICPR and Pond Pack may also be used.

The following 9-step procedure, based on the Rational Method, may be used to determine the required volume of storage.

Step	Procedure
1.	Determine total drainage area in acres "A".
2.	Determine the parcel area tributary to each outlet and determine the post-development 100 year release runoff rate (Qu) based on general release rates provided in Chapter 5 of these Technical Standards.
3.	Determine composite runoff coefficient "Cd"based on developed conditions and a 100 year return period.
4.	Determine 100-year return rainfall intensity "Id" for various storm durations "td" up through the time of concentration for the developed area using Table 1-4.

5. Determine developed inflow rates "Qd" for various storm durations "td", measured in hours.

$$Qd = (Cd)(Id)(Ad)$$

6. Compute a storage rate "S(td)" for various storm durations "td" up through the time of concentration of the developed area.

$$S(td) = (Qd)-(Qu)$$

7. Compute required storage volume "SR" in acre-feet for each storm duration "td". This assumes a triangular hydrograph of duration (2td) hours with a peak flow of S(td) at td hours.
8. Select largest storage volume computed in Step 7 for any storm duration "td" for detention basin design.
9. Repeat Steps 2-8 of this process for the post-developed 10-year storm.

B. Development sites greater than 5 acres in size or contributing drainage area greater than 50 acres or with significant depressional storage.

All runoff detention storage calculations for these development sites shall be prepared using a computer model that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies.
Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D). The 24-hour NOAA Atlas 14 Rainfall Distribution shall be utilized to determine the required storage volume.

The allowable release rates shall be determined based on the methodologies provided in Chapter 5 of this Technical Standards Manual. Examples of computer models such as Win TR-55 or Win TR-20 Watershed Hydrology that can generate hydrographs based on the NOAA Atlas 14 Point Precipitation Frequency Estimates for Indiana.

If interconnected ponds are utilized, the use of iCPR or Pond Pack may be required to appropriately model the more complex hydrologic and hydraulic relationships associated with such system.

Other models may be acceptable and must be approved by the Madison County Drainage Board or their designated Representative prior to their utilization.

Chapter Three

STORM SEWER DESIGN STANDARDS AND SPECIFICATIONS

All storm sewers, whether private or public, and whether constructed on private or public property shall conform to Madison County Design Standards as well as the other requirements contained herein.

A. Design Storm Frequencies

1. All storm sewers, inlets, catch basins, and street gutters shall accommodate (subject to the "allowable spread" provisions discussed later in this Section), at a minimum, peak runoff from a 10-year return frequency storm calculated based on methodology described in Chapter 1. Additional discharges to storm sewer systems allowed in Section "L" below of this Section must be considered in all design calculations. If the Rational Method analysis is utilized for design, the duration shall be equal to the time of concentration for the drainage area. In computer based analysis, the duration is as noted in the applicable methodology associated with the computer program.

2. Culverts shall be capable of accommodating, without overtopping the road, peak runoff from a 50-year frequency storm when crossing under a road or only other access to any portion of any commercial or residential development.

3. The allowable spread of water on Collector Streets, for portions of the system considered minor drainage systems, is limited to maintaining two clear 10-foot moving lanes of traffic. One lane is to be maintained on local roads, while other access lanes (such as a subdivision cul-de-sac) can have a water spread equal to one-half of their total width. An overflow channel/swale between sag inlets and overflow paths or basin shall be provided at sag inlets so that the maximum depth of water that might be ponded in the street sag shall not exceed 7 inches measured from the elevation of the gutter.

4. Facilities functioning as a major drainage system as defined in Appendix A must also meet IDNR design standards in addition to Madison County Standards. In case of discrepancy, the most restrictive requirements shall apply.

B. Manning's Equation

Determination of hydraulic capacity for storm sewers sized by the Rational Method analysis must be done using Manning's Equation. where:

$$V = (1.486/n)(R2/3)(S1/2)$$

Then:

$$Q = (V)(A)$$

Where:

Q= capacity in cubic feet per second
V= mean velocity of flow in feet per second
A = cross sectional area in square feet
R = hydraulic radius in feet
S = slope of the energy grade line in feet per foot
n = Manning's "n" or roughness coefficient

The hydraulic radius, R, is defined as the cross sectional area of flow divided by the wetted flow surface or wetted perimeter. Allowable "n" values and maximum permissible velocities for storm sewer materials are listed in Table 3-1.

C. Backwater Method for Pipe System Analysis

A more sophisticated design/analysis methodology other than Manning's equation will be required for the hydraulic analysis of existing or proposed storm drains which possess submerged outfalls. The backwater analysis method provides a more accurate estimate of pipe flow by calculating individual head losses in pipe systems that are surcharged and/or have submerged outlets. These head losses are added to a known downstream water surface elevation to give a design water surface elevation for a given flow at the desired upstream location.

Total head losses may be determined as follows:

Total head loss = frictional loss + manhole/inline BMP loss + velocity head loss + junction loss.

TABLE 3-1

Typical Values of Manning's "n"

Material	Manning's "n"	Maximum Velocities (feet/second)
Closed Conduits		
concrete	0.013	10
vitrified clay	0.013	10
HDPE	0.012	10
PVC	0.011	10
Circular CMP, Annular Corrugations, 2 -2/3 x ½ inch		
Unpaved	0.024	7
25% Paved	0.021	7
50% Paved	0.018	7
100% Paved	0.013	7
Concrete Culverts	0.013	10
HDPE or PVC	0.012	10
Open Channels		
Concrete, Trowel Finish	0.013	10
Concrete, Broom Finish	0.015	10
Gunite	0.018	10
Riprap Placed	0.030	10
Riprap Dumped	0.035	10
Gabion	0.028	10
New Earth (1)	0.025	4
Existing Earth (2)	0.030	4
Dense Growth of Weeds	0.040	4
Dense Weeds and Brush	0.040	4
Swale with Grass	0.035	4

Source of manning "n" values: HERPICC Stormwater Drainage Manual, July 1995.
(1) New earth (uniform, sodded, clay soil)
(2) Existing earth (fairly uniform, with some weeds).

Various computer modeling programs such as HYDRA, ICPR, ILLUDRAIN, and STORMCAD are available for analysis of storm drains under these conditions. Computer models to be utilized, other than those listed, must be approved and accepted by the Madison County Drainage Board or their designated representative.

D. Minimum Size for Storm Sewers

The minimum diameter of all storm sewers, with the exception of detention outlets, shall be 12 inches. When the minimum 12-inch diameter pipe will not limit the rate of release to the required amount, the rate of release for detention storage shall be controlled by an orifice or other approved means subject to the approval and acceptance of the Madison County Drainage Board or their designated Representative prior to their utilization.

E. Pipe Cover, Grade, and Separation from Sanitary Sewers

Pipe grade shall be such that, in general, a minimum of 2.0 feet of cover is maintained over the top of the storm pipe. Pipe cover less than the minimum may be allowed per manufacturer's specifications or recommendation and used only upon approval and acceptance from the Madison County Drainage Board or their designated representative. However, the applicant must show that such lesser cover depth would still insure structural integrity of the pipe. Uniform slopes shall be maintained between inlets, catch basins manholes and inlets and catch basins to manholes. Final grade shall be set with full consideration of the capacity required, sedimentation problems, and other design parameters. Minimum and maximum allowable slopes shall be those capable of producing velocities of between 2.0 and 10 feet per second, respectively, when the sewer is flowing full. Maximum permissible velocities for various storm sewer materials are listed in Table 3-1. A minimum of 2.0 feet of vertical separation between storm sewers and sanitary sewers shall be required. When this is not possible, a crossing method approved by the Madison County Drainage Board or their designated Representative shall be utilized.

F. Alignment

Storm sewers shall be straight between manholes, inlets, and catch basins.

G. Manholes/inlets/Catch Basins

All inlets, catch basins, and manhole castings must be pre-stamped with an appropriate "clean water" message. Manholes, catch basins and inlets shall be installed to provide human access to continuous underground storm sewers for the purpose of inspection and maintenance. The casting access minimum inside diameter shall be no less than 22 inches or a rectangular opening of no less than 22 inches by 22 inches. Manholes shall be provided at the following locations:

1. Where two or more storm sewers converge.
2. Where pipe size or the pipe material changes.
3. Where a change in horizontal alignment occurs.
4. Where a change in pipe slope occurs.
5. At intervals in straight sections of sewer, not to exceed the maximum allowed. The maximum distance between storm sewer manholes shall be as shown in Table 3-2.

TABLE 3-2

Maximum Distance Between Manholes

Size of Pipe (Inches)	Maximum Distance (Feet)
12 - 42	400
48 and above	600

Pipe slope should not be so steep that inlets surcharge (i.e. hydraulic grade line should remain below rim elevation).
Catch basin and inlet inside sizing shall be as shown in Table 3-3 but not less than 1.5 times the diameter of the largest pipe entering the structure.

6. Inlet / Catch Basin Inside Dimensions shall be as shown in Table 3-3

TABLE 3-3

Catch Basin/Inlet Inside Sizing

Depth of Structure	Minimum Diameter	Minimum Square Opening
Less than 5 feet	24"	24" x 24"
5 Feet or More	30"	30" x 30"

7. Manholes shall have a minimum of 48 inch inside diameter but not less than 1.5 times the largest diameter pipe entering the manhole.
8. Manholes, inlets, and catch basins shall also conform to the design and installation standards depicted in the Appendix.

H DRIVEWAY CULVERTS

All driveway / county road culverts shall be at the sizes and locations as approved by the Madison County Engineer. Proper permits must be obtained prior to the installation of these culverts.

I INLET SIZING AND SPACING

Inlets or other drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels, or culverts. The inlet grate opening provided shall be adequate to pass the design 10-year flow with 50% of the sag inlet areas clogged. An overload channel from sag inlets to the overflow channel or basin shall be provided at sag inlets. Inlet design and spacing may be done using the hydraulic equations by manufacturers or orifice/weir equations. Use of the U.S. Army Corps of Engineers HEC-12 computer program is also an acceptable method. Gutter spread on continuous grades may be determined using the Manning's equation, or by using Figure 3-1. The maximum inlet spacing shall be 200 feet unless otherwise approved by the Madison County Drainage Board or their authorized representative.

J. Installation and Workmanship

Bedding and backfill materials around storm sewer pipes, sub-drains, and the associated structures shall not be less stringent than those set forth in the latest edition of the "INDOT Standard Specifications". Additionally, ductile iron pipe shall be laid in accordance with American Water Works Association (AWWA) C-600. Dips/sags on newly installed storm systems will not be permitted. Infiltration from cracks, missing pieces, and at joints shall not be permitted. Any variations from these standards must be justified and are to receive written acceptance and approval from the Madison County Drainage Board or their designated representative.

K. Materials

Storm sewer manholes, inlets, and catch basins shall be constructed of cast-in-place reinforced concrete or precast reinforced concrete. Material and construction shall conform to the latest edition of the Indiana Department of Transportation (INDOT) "Standard Specifications", Sections 702 and 720.

Pipe and fittings used in storm sewer construction shall be ductile iron pipe (AWWA C-151), poly vinyl chloride pipe (AASHTO M252), polyethylene pipe (AASHTO M252 or AASHTO M294), or concrete pipe (AASHTO M170). Other pipe and fittings not specified herein or in Sections 907-908 of the latest edition of the INDOT "Standard Specifications" may be used only when specifically authorized by the Madison County Drainage Board or their designated representative. Pipe joints shall be flexible and watertight and shall conform to the requirements of Section 906, of the latest edition of the INDOT "Standard Specifications".

L. Special Hydraulic Structures

Special hydraulic structures required to control the flow of water in storm runoff drainage systems include junction chambers, drop manholes, stilling basins, and other special structures. The use of these structures shall be limited to those locations justified by prudent planning and by careful and thorough hydraulic engineering analysis. Certification of special structures by a Indiana Licensed Structural Engineer may also be required if deemed necessary by the Madison County Drainage Board or their designated representative.

M. Connections to Storm Sewer Systems, Regulated Tiles and Drains

To allow any connections to the storm sewer systems, including Regulated Tiles and Open Drains, provisions for the connections shall be shown in the drainage calculations for the system. Specific language shall be provided in the protective covenants, on the record plat, and/or with the parcel deed of record, noting the ability or inability of the system to accommodate any additional permitted connections, i.e. sump pumps, crawl space and footing drains.

1. Sump pumps installed to receive and discharge groundwater or other stormwater shall be connected to the storm sewer where possible or discharged into a designated storm drainage channel/swale. Sump pumps installed to receive and discharge

floor drain flow or other sanitary sewage shall not be connected to the storm sewer system.

2. Footing drains and perimeter drains may be connected to storm manholes, curb inlets, or catch basins in a manner approved by the Madison County Drainage Board or their designated representative. If the preceding structures are not available for connection, then other connections may be made with the approval of and in a manner accepted by the Madison County Drainage Board or their designated representative.
3. Roof downspouts, roof drains, or roof drainage piping may be connected to storm manholes, curb inlets, or catch basins in a manner approved by the Madison County Drainage Board or their designated representative. If the preceding structures are not available for connection, then other connections may be made with the approval of the Madison County Drainage Board or their designated representative.
4. Garage and basement floor drains shall not be connected to the storm sewer system. These drains may be routed to a properly designed wet well.
5. Swimming pool drains shall not be connected to the storm sewers unless the water is properly dechlorinated, as defined in Appendix A, prior to connection and discharge to the storm sewer system.

In addition, none of the above mentioned devices shall be connected to any street underdrains, unless specifically authorized by the Madison County Drainage Board or their designated representative.

N. Drainage System Overflow Design

Overflow path/ponding areas throughout the development resulting from a 100 year storm event, calculated based on all contributing drainage areas, on-site and off-site, in their proposed or reasonably anticipated land use and with storm pipe system assumed completely plugged, shall be determined, clearly shown as hatched area on the plans, and a minimum width of 30 feet along the centerline of the flow path contained in permanent drainage easements. A statement shall be added to the plat that refers the viewer to the construction plans to see the entire extent of overflow path as hatched areas. No fences or landscaping can be constructed within the easement areas that may impede the free flow of stormwater. These areas are to be maintained by the property owners or be designated as common areas that are to be maintained by the homeowners association. The lowest adjacent floor or crawl space grade for all residential, commercial, or industrial buildings shall be set a minimum of 1 foot above the noted overflow path/ponding highest elevation.

All buildings shall have a minimum flood protection grade shown on the secondary plat. Minimum Flood Protection Grade of all structures fronting a pond or open ditch shall be no less than 2 feet above any adjacent 100-year local or regional flood elevations, whichever is greater, for all windows, doors, unsealed pipe entrances, window well rim elevations, and any other structure member where floodwaters can enter a building.

The overflow path/ponding may be modeled as successive series of natural ponds and open channel segments. Ponds should be modeled similar to that discussed for modeling depressional areas in Chapter 5. Channels should be modeled according to modeling techniques discussed in Chapter 4. The calculations for determining the 100-year overflow path/ponding elevations may be based on hand calculation methods utilizing normal depth calculations and storage routing techniques or performed by computer models. Examples of computer models that either individually or in combination with other models can handle the required computations include TR-20, HEC-HMS, and HEC-l, combined with HEC-RAS. Other models may be acceptable. However, their use must be approved by the Madison County Drainage Board or their designated representative prior to their utilization.

Values in Table 3-4 may be utilized as an alternative to the above-noted detailed calculations for determining the required pad elevations of buildings near an overflow path.

TABLE 3-4

Building Pad Elevations With Respect to Overflow Path Invert Elevations

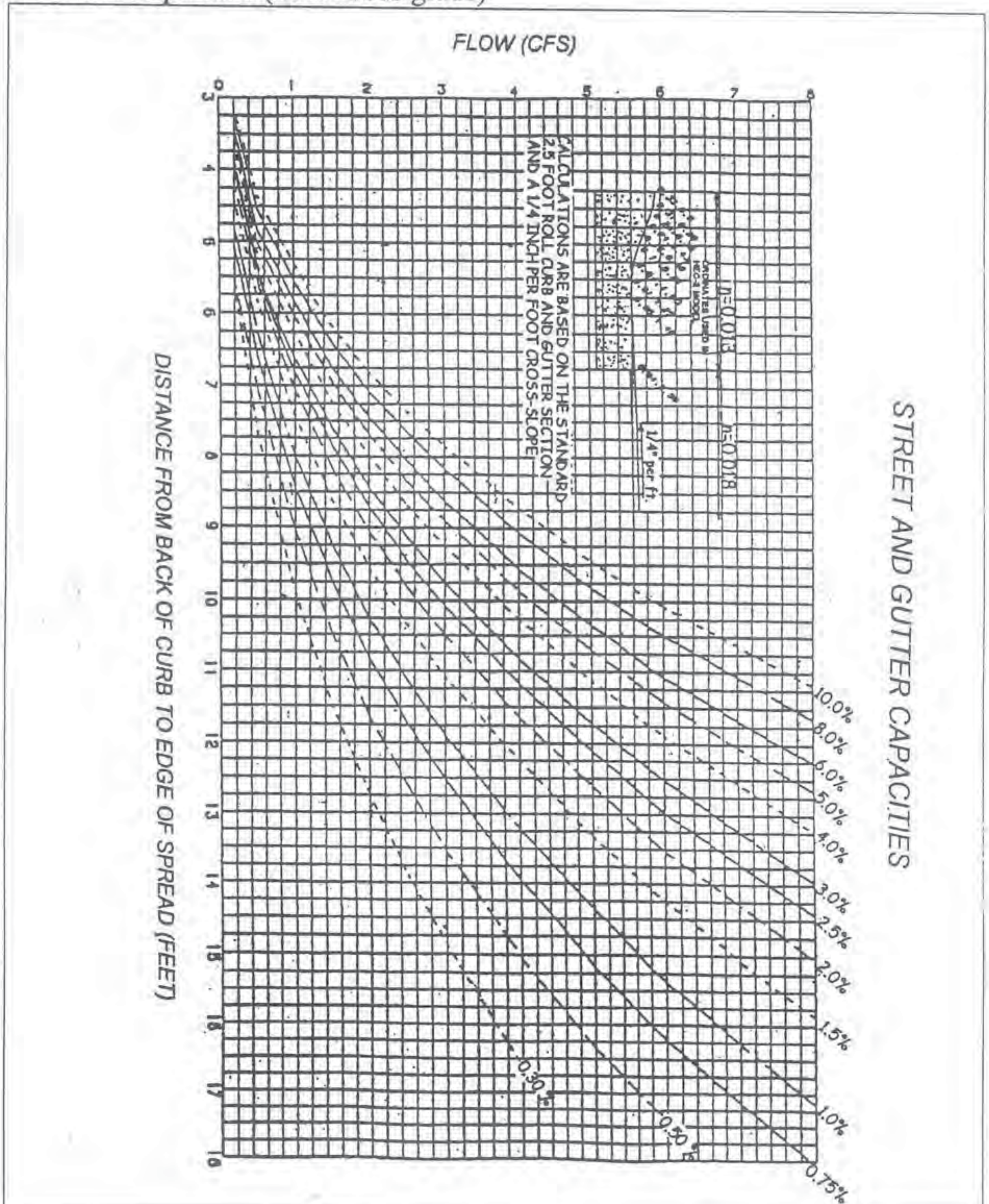
Drainage Area (acres)	Building Pad Above Overflow Path Invert (ft.)	Building Pad Above Overflow Path Invert, if Overflow Path is in the Street (ft.)
Up to 5	2.5	1.5
6-10	3.0	1.50
11-15	3.25	1.75
16-20	3.5	1.75
21-30	4.0	2.0
30-50	4.25	2.0

If Table 3-4 is used, the Madison County Drainage Board reserves the right to require independent calculations to verify that the proposed building pads provide approximately 1 foot of freeboard above the anticipated overflow path/ponding elevations.

In the case of existing upstream detention, an allowance equivalent to the reduction in flow rate provided may be made for upstream detention only when:

(1) such detention and release rate have previously been accepted by either the Madison County Drainage Board or other proper Official of a municipality charged with the approval authority at the time of the acceptance, and (2) evidence of its construction and maintenance can be shown.

FIGURE 3-1
Street and Gutter Capacities (continuous grade)



Chapter Four

OPEN CHANNEL DESIGN STANDARDS AND SPECIFICATIONS

All channels, whether private or public, and whether constructed on private or public land, shall conform to the Madison County Drainage Board Design Standards as well as other design requirements contained herein.

A. Design Storm Frequencies

1. All channels and swales shall accommodate, at a minimum, peak runoff from a 10-year return frequency storm calculated based on methodology described in Chapter 1. The storm duration shall be equal to the time of concentration for the drainage area if the Rational Method is utilized for analysis. In computer-based analysis, the duration is as noted in the applicable methodology associated with the computer program.

2. Channels with a carrying capacity of more than 30 cfs at bank-full stage shall be capable of accommodating peak runoff for a 50-year return frequency storm within the drainage easement.

3. Channel facilities functioning as a major drainage system, as defined in Appendix A, must also meet IDNR design standards in addition to these Madison County Drainage Board Standards. In case of conflicting standards, the most restrictive requirements shall apply.

4. The 10-year storm design flow for residential rear and side lot swales shall not exceed 4 cfs. Unless designed as a Post-construction stormwater quality BMP, the maximum length of Subdivision rear and side lot swales before reaching any inlet shall not exceed 300 feet and shall not convey flow from more than 12 lots.

5. Regardless of minimum design frequencies stated above, the performance of all parts of the design drainage system shall be checked for the 100-year flow conditions to insure that all buildings are

properly located outside the 100year flood boundary and that flow paths are confined to designated areas with sufficient easement.

B. Manning's Equation

The waterway area for channels shall be determined using Manning's Equation, where:

$$A = Q/V$$

A = Waterway area of channel in square feet

Q = Discharge in cubic feet per second (cfs)

V= Steady-State channel velocity, as defined by Manning's Equation (See Chapter 3)

C. Backwater Method for Drainage System Analysis

The determination of 100-year water surface elevation along channels and swales shall be based on accepted methodology and computer programs designed for this purpose. Computer programs HEC-RAS, HEC-2, and ICPR are accepted and preferred programs for conducting such backwater analysis. The use of other computer models must be accepted and approved by the Madison County Drainage Board or their designated representative in advance of their utilization.

D. Channel Cross-Section and Grade

1. The required channel cross-section and grade are determined by the design capacity, the material in which the channel is to be constructed, and the requirements for maintenance. A

minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. The channel grade shall be such that the velocity in the channel is high enough to prevent siltation but low enough to prevent erosion. Velocities less than 2 feet per second (fps) are not acceptable, as siltation will take place and ultimately reduce the channel cross-section area. The maximum permissible velocities in vegetated-lined channels are shown in Table 4-1. In addition to existing runoff, the channel design should incorporate increased runoff due to the proposed development.

2. Where depth of design flow is slightly below critical depth, channels shall have freeboard adequate to cope with the effect of hydraulic jumps.

3. Along the streets and roads, the bottom of the ditch should be low enough to install adequately-sized driveway culverts without creating "speed bumps". If necessary to obtain adequate pipe cover the pipe invert shall be lowered to a depth below the ditch invert. The ditch and driveway culvert inverts shall be designed to adequately consider upstream and downstream ditch and culvert elevations.

4. With the exception of Detention Basin Outflows, flow of a open channel into a closed system is prohibited, unless runoff rate and head loss computations demonstrate the closed conduit to be capable of carrying the 100-year channel flow for developed conditions, either entirely or in combination with a defined overflow channel, with no reduction of velocity.

TABLE 4-1

Maximum Permissible Velocities in Vegetal-Lined Channels(l)

Cover	Channel Slope Range (Percent) (3)	Permissible Velocity (2) Erosion Resistant Soils (ft. per sec.) (4)	Easily Eroded Soils (ft. per sec.) (4)
Bermuda Grass	0-5	8	6
	5-10	7	5
	Over 10	6	4
Bahia, Buffalo Grass,			
Kentucky Bluegrass	0-5	7	5
Smooth Brome	5-10	6	4
Blue Grama	Over 10	5	3
Grass Mixture	(3)0-5	5	4
Reed Canary Grass	5-10	4	3
Lespedeza Sericea	(4)		
Weeping Lovegrass			
Yellow Bluestem	0-5	3.4	2.5
Redtop, Alfalfa,			
Red Fescue	5-10	3.4	2.5
Common	(6)		
Lespedza (5)	0-5	3.5	2.5
Sudangrass (5)			

(1) From Soil Conservation Service, SCS-TP-61, "Handbook of Channel Design for Soil and Water Conservation".

(2) Use velocities exceeding 5 feet per second only where good channel ground covers and proper maintenance can be obtained.

(3) Do not use on slopes steeper than 10 percent except for vegetated side

slopes in combination with a stone, concrete, or highly resistant vegetative center section.

(4) Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

(5) Annuals -use on mild slopes or as temporary protection until permanent covers are established.

(6) Use on slopes steeper than 5 percent is not recommended.

E. Side Slopes

1. Earthen channel and swale side slopes shall be no steeper than 3 horizontal to 1 vertical (3: 1). Flatter slopes may be required to prevent erosion and for ease of maintenance.

2. Where channels will be lined with riprap, concrete, or other acceptable lining method, side slopes shall be no steeper than 2 horizontal to 1 vertical (2: 1) with adequate provisions made for weep holes.

3. Side slopes steeper than 2 horizontal to 1 vertical (2: 1) may be used for lined channels provided that the side lining is designed and constructed as a structural retaining wall with provisions for live and dead load surcharge.

4. When the design discharge produces a depth of greater than three (3) feet in the channel, appropriate safety precautions shall be added to the design criteria based on reasonably anticipated safety needs.

F. Channel Stability

1. Characteristics of a stable channel are:

   a. It neither promotes sedimentation nor degrades the channel bottom and sides.
   b. The channel banks do not erode to the extent that the channel cross-section is changed appreciably.
   c. Excessive sediment bars do not develop.
   d. Excessive erosion does not occur around culverts, bridges, outfalls or elsewhere.
   e. Gullies do not form or enlarge due to the entry of uncontrolled flow to the channel.

2. Channel stability shall be determined for an aged condition and the velocity shall be based on the design flow or the bankfull flow, whichever is greater, using an "n" value for various channel linings as shown in Tables 3-1 and 4-1. In no case is it necessary to check channel stability for discharges greater than that from a 100-year frequency storm.

3. Channel stability shall be checked for conditions representing the period immediately after construction. The velocity for this stability analysis shall be calculated for the expected flow from a 10-year frequency storm on the watershed, or the bankfull flow, whichever is smaller, and the "n" value for the newly constructed channels in fine-grained soils and sands may be determined in accordance with the "National Engineering Handbook 5, Supplement B, Soil Conservation Service" and shall not exceed 0.025. The allowable velocity in the newly constructed channel may be increased by a maximum of 20

percent to reflect the effects of vegetation to be established under the following conditions:

a. The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion controlling vegetation.
b. Species of erosion controlling vegetation adapted to the area, and proven methods of establishment are shown.
c. The channel design includes detailed plans for establishment of vegetation on the channel side slopes.

G. Drainage of Swales

Minimum swale slopes are 1.0% unless designed to act as a post-construction stormwater quality BMP. All flow shall be confined to the specific easements associated with each rear and side lot swale that are part of the minor drainage system. Unless designed to act as a stormwater quality BMP, vegetated swales under 1% grade shall have tile underdrains to dry the swales. Tile lines may be outletted through a drop structure at the ends of the swale or through a standard tile outlet. Further guidance regarding this subject may be found in the latest edition of the Indiana Drainage Handbook.

H. Appurtenant Structures

The design of channels will include provisions for operation and maintenance and the proper functioning of all channels, laterals, travelways, and structures associated with the project. Recessed inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the design of channel improvements. The design will also provide for necessary floodgates, water level control devices, and any other appurtenance structure affecting the functioning of the channels and

the attainment of the purpose for which they are built.
The effects of channel improvements on existing culverts, bridges, buried cables, pipelines, and inlet structures for surface and subsurface drainage on the channel being improved and laterals thereto shall be evaluated to determine the need for modification or replacement. Culverts and bridges which are modified or added as part of channel improvement projects shall meet reasonable standards for the type of structure, and shall have a minimum capacity equal to the design discharge or governmental agency design requirements, whichever is greater.

I. Deposition of Spoil

Spoil material resulting from clearing, grubbing, and channel excavation shall be disposed of in a manner that will:

1. Minimize overbank wash.

2. Provide for the free flow of water between the channel and flood plain boundary without overbank flows.

3. Not hinder the development of travelways for maintenance.

4. Leave the right-of-way in the best condition feasible, consistent with the project purposes, for productive use by the land owner.

5. Be accepted by IDEM, IDNR and the ACOE if applicable and the Madison County Drainage Board.

J. Materials

Materials acceptable for use as channel lining are:

1. Grass (hand sown or hydroseeded)

2. Revetment Riprap

3. Concrete

4. Hand Laid Riprap

5. Precast Cement Concrete Riprap

6. Gabions (or reno mattresses)

7. Straw or Coconut Mattings or erosion control blanket (only until grass is established)

Other lining materials must be presented and approved in writing by the Madison County Drainage Board or their designated representative. Materials shall comply with the latest edition of the INDOT, "Standard Specifications".

K. Drainage System Overflow Design

Ponding and overflow path throughout the development resulting from a 100-year storm event, calculated based on all contributing drainage areas, on-site and offsite, in their proposed or reasonably anticipated land use and with the storm pipe system assumed completely plugged, shall be determined, clearly shown as hatched area on the plans, and at 30 feet along the centerline of the overflow path contained in permanent drainage easements. A statement shall be added to the plat or deed that would refer the viewer to the approved construction plans to see the entire extent of overflow path as hatched areas. No fences or landscaping can be constructed within the easement areas that may impede the free flow of stormwater. These areas are to be maintained by the property owners or be designated as common areas that are to be maintained by the homeowners association. The lowest adjacent

grade for all residential, commercial, or industrial buildings shall be set a minimum of 1 foot above the noted overflow path/ponding elevation (not to be confused with BFE).
The overflow path/ponding may be modeled as a successive series of natural ponds and open channel segments. Ponds should be modeled similar to that discussed for modeling depressional areas in Chapter 5. Channels should be modeled according to modeling techniques discussed earlier in this Chapter. The calculations for determining the 100-year overflow path/ponding elevations may be based on hand calculation methods utilizing normal depth calculations and storage routing techniques or performed by computer models. Examples of computer models that either individually or in combination with other models can handle the required computations include TR-20, HEC-HMS, and HEC-I, combined with HEC-RAS and ICPR. Other models may be acceptable and must be approved by the Madison County Drainage Board or their designated representative prior to their utilization.

Values in Table 3-4 may be utilized as an alternative to the above-noted detailed calculations for determining the required pad elevations of buildings near an overflow path.

If Table 3-4 is used, the Madison County Drainage Board, or their designated representative reserves the right to require independent calculations to verify that the proposed building pads provide approximately 1 foot of freeboard above the anticipated overflow path/ponding elevations (not to be confused with BFE).

In the case of existing upstream detention, an allowance equivalent to the reduction in flow rate provided may be made for upstream detention only when: (1) such detention and release rate have previously been accepted by the governing body charged with the approval authority at the time of the acceptance, and (2) evidence of its construction and maintenance can be shown.

Chapter Five

STORMWATER DETENTION DESIGN STANDARDS

The following shall govern the design of any improvement with respect to the detention of stormwater runoff. Basins shall be constructed to temporarily detain the stormwater runoff that exceeds the maximum peak release rate authorized by the Ordinance. The required volume of storage provided in these basins, together with such storage as may be authorized in other on-site facilities, shall be sufficient to control excess runoff from the 10-year or 100-year storm as explained below in Section "B". Also, basins shall be constructed to provide adequate capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings.

A. Acceptable Detention Facilities

The increased stormwater runoff resulting from a proposed development must be detained on-site by the provisions of appropriate wet bottom or dry bottom detention facilities, parking lots, or other acceptable techniques. Measures that retard the rate of overland flow and the velocity in runoff channels shall also be used to partially control runoff rates.

B. Allowable Release Rates

1. General Release Rates:
   Control devices shall limit the discharge to a rate such that the post developed release rate from the site is no greater than 0.3 cfs per acre of development for 0 to10 year return interval storms and 0.5 cfs per acre of developed area for 11 to 100 year return interval storms. The above fixed general release rates may be set at a lower value by the Madison County Drainage Board for certain watersheds if more detailed data becomes available as a result of comprehensive watershed studies conducted and/or

formally approved and adopted by the Madison County Drainage Board The applicant shall confirm the applicable release rates with the Madison County Drainage Board or their designated representative prior to initiating the design calculations to determine whether a basin-specific rate has been established for the watershed. The release rate, when computed for a pre-developed area that has more than one (1) outlet, must be based on the pre-developed discharge rate for each outlet point. The computed release rate for each outlet point shall not be exceeded at the respective outlet point even if the post-developed conditions would involve a different arrangement of outlet points.

2. Site-Specific Release Rates for Sites with Depressional Storage: The general release rates provided above may have to be further reduced when utilized for sites where depressional storage exists. If depressional storage exists at the site, site-specific release rates must be calculated according to methodology described in Chapter 1, accounting for the depressional storage by modeling it as a pond whose outlet is a weir at an elevation that stormwater can currently overflow the depressional storage area. Post developed release rate for sites with depressional storage shall be the 2-year pre-developed peak runoff rate for the post-developed 10year storm and 10-year pre-developed peak runoff rate for the post developed 100-year storm. In no case shall the calculated site-specific release rates be larger than general release rates as outlined above.
Depressional storage by definition does not have a direct gravity outlet but if in agricultural production, it is more than likely drained by a tile and should be modeled as "empty" at the beginning of a storm. The function of any existing depressional storage should be modeled using an event hydrograph model to determine the volume of storage that exists and its effect on the

existing site release rate. To prepare such a model, certain information must be obtained, including delineating the tributary drainage area, the stage-storage relationship and discharge-rating curve, and identifying the capacity and elevation of the outlet(s).

The tributary area should be delineated on the best available topographic data. After determining the tributary area, a hydrologic analysis of the watershed should be performed, including, but not limited to, a calculation of the appropriate composite runoff curve number and time of concentration. Stage-storage data for the depressional area should be obtained from the site topography. The outlet must be clearly marked and any calculations performed to create a stage-discharge rating curve must be included with the stormwater submittals.

The depressional storage must be assumed to be filled, when determining the post-developed peak runoff rates, unless the Madison County Drainage Board or their designated representative can be assured, through a dedicated easement, that the noted storage will be preserved in perpetuity.

3. Management of Off-site Runoff:

Runoff from all upstream tributary areas (off-site land areas) may be bypassed around the detention/retention facility without attenuation. Such runoff may also be routed through the detention/retention facility, provided that a separate secondary outlet system is incorporated for the safe passage of such flows, i.e., not through the primary outlet of a detention facility. Unless the pond is being designed as a regional detention facility and therefore all off-site runoff to the pond detained, the primary outlet structure shall be sized and the invert elevation of the secondary outlet for bypassing off-site runoff determined according to the on-site runoff only. To accomplish this, the 100-year on-site runoff must be determined by temporarily ignoring the off-site runoff and routed through the pond and through the primary outlet pipe. The resulting pond elevation would be the invert elevation of the secondary outlet. Once the size and location of primary outlet structure and the invert elevation of the secondary outlet for bypassing off-site runoff are determined by considering on-site runoff only, the size of the secondary outlet and the 100-year pond elevation is determined by routing the entire inflow, on-site and off-site, through the pond. Once the 100-year pond elevation is determined in this manner, the crest elevation of the open emergency weir is set at that elevation.

The efficiency of the detention/retention facility in controlling the on-site runoff may be severely affected if the off-site area is considerably larger than the on-site area. As a general guidance, in-line detention may not be effective in controlling on-site runoff where the ratio of off-site area to onsite area is greater than 5: 1. Additional detention (above and beyond that required for on-site area) may be required by the Madison County Drainage Board when the ratio of off-site area to on-site area is larger than 5: 1.

4. Downstream Restrictions:

In the event the downstream receiving channel or storm sewer system is inadequate to accommodate the post-developed release rate provided above, then the allowable release rate shall be reduced to that rate permitted by the capacity of the receiving downstream channel or storm sewer system. Additional detention, as determined by the Madison County Drainage Board, shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways. When such downstream restrictions are determined, the Madison County Drainage Board may require additional analysis to determine the receiving system's limiting downstream capacity.

If the proposed development makes up only a portion of the undeveloped watershed upstream of the limiting restriction, the allowable release rate for the development shall be in direct

proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.
As an alternative to reduction of release rates, the Madison County Drainage Board may allow the applicant to pursue alleviating downstream restrictions by other means acceptable and approved by the Board.

5. Documentation of Results:
The results of the allowable release rate determinations as well as the modeling simulation results must be summarized in a table that shall be included in the Stormwater Drainage Technical Report and on the Drainage Plan. The table must include, for each eventual site outlet, the pre-developed acreage tributary to each eventual site outlet, the unit discharge allowable release rate used, the resulting allowable release rate in cfs for the post-developed 10-year and 100-year events, pre-developed 2-year flow rates in cfs as well as pre-and post-developed flow rates for 10-and 100-year events.

C. General Detention Basin Design Requirements

1. The detention facility shall be designed in such a manner that a minimum of 90% of the maximum volume of water stored and subsequently released at the design release rate shall not result in a storage duration in excess of 48 hours from the start of the storm unless additional storms occur within the period. In other words, the design shall ensure that a minimum 90% of the original detention capacity is restored within 48 hours from the start of the design 100-year storm.

2. The 100-year elevation of stormwater detention facilities shall be separated by not less than 25 feet from any building or structure to be occupied. The Lowest Adjacent Grade (including walkout basement floor elevation) for all residential, commercial, or industrial buildings shall be set a minimum of 2

feet above the 100-year pond elevation or 2 feet above the emergency overflow weir elevation, whichever is higher. In addition to the lowest adjacent grade requirements, any basement floor must be at least one (1) foot above the normal water level of any wet-bottom pond or the local groundwater table, whichever is higher.

3. No detention facility or other water storage area, permanent or temporary, shall be constructed within twenty (20) feet of any pole or high voltage electric line tower. Likewise, poles or high voltage electric line towers shall not be placed within twenty (20) feet of any detention facility or other water storage area; however, detention ponds may be placed beneath high voltage electric lines.

4. All stormwater detention facilities shall be separated from any road right of-way by no less than 20 feet, measured from the top of bank or slope or the 100 year pool if no defined top of bank is present, using the most restrictive right-of-way possible. Use of guard rails, berms, or other structural measures may be considered in lieu of the above-noted setbacks.

5. Slopes no steeper than 3 horizontal to 1 vertical (3: 1) for dry bottom detention facilities and 2 horizontal to 1 vertical (2 : 1) for wet bottom detention ponds for safety, erosion control, stability, and ease of maintenance shall be permitted.

6. Debris Guards shall be provided for any pipe or opening.

7. Outlet control structures shall be designed to operate as simply as possible and shall require little or no maintenance and/or attention for proper operation. The outlet from the pond shall be above the normal water level of the receiving water body. Discharges into existing or planned downstream channels or conduits shall be limited so as not to exceed the predetermined maximum authorized peak flow rate. If a control structure outlet from above ground facilities includes an orifice to restrict the

flow rate, such orifice shall be no less than 6 inches in diameter, even if the 6 inch diameter orifice results in a discharge that exceeds the predetermined maximum authorized peak flow release rates as determined using methodologies in Section B (above).

8. Emergency overflow facilities such as a weir or spillway shall be provided for the release of exceptional storm runoff or in emergency conditions should the normal discharge devices become totally or partially inoperative. The overflow facility shall be of such design that its operation is automatic and does not require manual attention.

Emergency overflow facilities shall be designed to handle one and one-quarter (1.25) times the peak discharge and peak flow velocity resulting from the 100-year design storm event runoff from the entire contributing watershed draining to the detention/retention facility (pond total peak 100year inflow), assuming post-development conditions on-site and existing conditions off-site.

The emergency overflow routing from the emergency overflow facility to an adequate receiving system must be positive (by gravity) and sized to handle the design flow of the emergency overflow facility as provided above. The noted emergency overflow path must be shown on the construction plans and on the plat of a subdivision, and a minimum width of 30 feet along the centerline of the flow path contained in permanent drainage easement. Such easement is necessary to ensure adequate maintenance access and no obstructions (including fences, landscaping, regrading, etc.) shall be allowed. The lowest adjacent grade (including walkout basement floor elevation) for all residential, commercial, or industrial buildings shall be set a minimum of 2 feet above the elevation of the design flow along the path.

9. Grass or other suitable vegetative cover shall be provided along The banks of the detention storage basin. Vegetative cover around detention facilities must be maintained as appropriate. The Madison County Drainage Board will not be responsible for maintenance of the detention pond and bank slopes.

10. Debris and trash removal and other necessary maintenance shall be performed on a regular basis to assure continued operation in conformance to design. The Madison County Drainage Board will not be responsible for pond maintenance.

11. No platted residential lots, or any part thereof, shall be used for any part of a detention basin, assumed full to the 100-year water surface elevation or the emergency overflow weir elevation, whichever is higher unless specifically approved by the Madison County Drainage Board. Detention basins, assumed full to the 100-year water surface elevation or the emergency overflow weir elevation, whichever is higher, shall be placed within a common area either platted or legally described and recorded as a perpetual stormwater easement. A minimum of twenty-five (25) feet horizontally from the top of bank of the facility, or the 100-year pool if no defined top of bank is present, shall be dedicated as permanent stormwater easement if the above-noted boundary of the common area does not extend that far.

12. A minimum of a twenty (20) foot wide drainage and utility easement shall be provided for access to any detention basin.

D. Additional Requirements for Wet-Bottom Facility Design

Where part of a detention facility will contain a permanent pool of water, all the items required for detention storage shall apply. Also, a controlled positive outlet will be required to maintain the design water level in the wet bottom facility and provide required detention storage above the design water level. However, the following additional conditions shall apply:

1. Facilities designed with permanent pools or containing permanent lakes shall have a water area of at least one-half (0.5) acre with a minimum depth of eight (8) feet over a minimum of 33 percent of the total pond area at normal pool. If fish are to be used to keep the pond clean, a minimum depth of between eight (8) to ten (10) feet shall be maintained over at least 25 percent of the pond area. The remaining pond area shall have no extensive shallow areas, except as required to install the safety ramp, safety ledge, and BMPs. Construction trash or debris shall not be placed within the permanent pool. The pond design shall be in accordance with E-81, Appendix "E", of these Standards.

2. A safety ramp exit from the pond may be required in some cases if specified by the Madison County Drainage Board or their designated Representative and shall have a minimum width of twenty (20) feet and exit slope of 6 horizontal to 1 vertical (6:1). The safety ramp shall be constructed of suitable material to prevent structural instability due to vehicles or wave action. In all other areas of the pond the safety ledge width shall not be less than five (5) feet.

3. Periodic maintenance is required in lakes to control weed and larval growth. The facility shall also be designed to provide for the easy removal of sediment that will accumulate during periods of reservoir operation. A means of maintaining the designed water level of the lake during prolonged periods of dry weather may also be required. The Madison County Drainage Board will not be responsible for pond maintenance.

4. Methods to prevent pond stagnation, including but not limited to surface or sub-surface aeration or destratification facilities that can, at the minimum, achieve one complete pond volume turnover per day should may be required by the Board. Irregularly shaped ponds should be treated as two or three separate ponds. Likewise, larger ponds may also need multiple aeration units. Design calculations to substantiate the effectiveness of proposed aeration facilities shall be submitted with final engineering plans. Agreements for the perpetual operation and maintenance of aeration facilities shall be prepared to the satisfaction of the Board.

E. Additional Requirements for Dry-Bottom Facility Design

In addition to general design requirements, detention facilities that will not contain a permanent pool of water shall comply with the following requirements:

1. Provisions shall be incorporated into facilities for complete interior drainage of dry bottom facilities, including a minimum 1% bottom slope in all directions if tile underdrains are provided and a minimum of 2% if no underdrains are provided. A positive/gravity outlet is required for the underdrains in all dry-bottom detention facilities.

2. The maximum planned depth of stormwater stored shall not exceed four (4) feet when dry-bottom facilities are utilized in residential developments.

3. In excavated detention facilities, a minimum side slope of 3: 1 shall be provided for stability.

F. Parking Lot Storage

Paved parking lots may be designed to provide temporary detention storage of stormwater on all or a portion of their surfaces. Outlets for parking lot storage of stormwater will be designed so as to empty the stored waters slowly. Depths of storage shall be limited to a maximum depth of seven (7) inches so as to prevent damage to parked vehicles and so that access to parked vehicles is not impaired. Ponding should in general, be confined to those locations of the parking lots farthest from the area served. A perpetual maintenance agreement must be executed by the owner or the developer of the parking lots and filed with the Madison County Drainage Board before such detention method is allowed. In addition, the 100-year inundation boundary should be determined and clearly shown on the construction plans.

G. Detention Facilities in Floodplains

No detention facilities are allowed to be placed within floodplains of any Regulated Drain or watercourse that has more than one (1) square mile of contributing drainage area .

H. Joint Development of Control Systems

Stormwater control systems may be planned and constructed jointly by two or more developers as long as compliance with the Ordinance and Standards is maintained.

I. Diffused Outlets

When the allowable runoff is released in an area that is susceptible to flooding or erosion, the developer may be required to construct appropriate storm drains through such area to avert increased flood hazard caused by the concentration of allowable runoff at one point instead of the natural overland distribution. The requirement of diffused outlet drains shall be at the discretion of the Madison County Drainage Board.

J. Allowance for Sedimentation

Detention basins shall be designed with an additional ten (10) percent of available capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings. Basins should be designed to collect sediment and debris in specific locations, such as a forebay, so that removal costs are kept to a minimum. The sediment allowance may be provided below the permanent pool elevation for -wet-bottom ponds. No construction trash or debris shall be allowed to be placed within the permanent pool. If the pond is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the pond and elevations and grades have been reestablished as established in the accepted plans.

Chapter Six

EROSION CONTROL PRACTICES AND CONSTRUCTION PHASE BMPS

The requirements contained in this Chapter are intended to prevent stormwater pollution resulting from soil erosion and sedimentation or from mishandling of solid and hazardous waste. Practices and measures included herein should assure that no foreign substance, (e.g. sediment, construction debris, chemicals) be transported from a site and allowed to enter any drainageway, whether intentionally or accidentally, by machinery, wind, rain, runoff, or other means.

A. POLLUTANTS OF CONCERN DURING CONSTRUCTION

The major pollutant of concern during construction is sediment. Natural erosion processes are accelerated at a project site by the construction process for a number of reasons, including the loss of surface vegetation and compaction damage to the soil structure itself, resulting in reduced infiltration and increased surface runoff. Clearing and grading operations also expose subsoils which are often poorly suited to re-establish vegetation, leading to longer term erosion problems.

Problems associated with construction site erosion include: transport of pollutants attached to displaced sediment; increased turbidity (reduced light) in receiving waters, and recreational use impairment. The deposited sediment may pose direct toxicity to wildlife, or smother existing spawning areas and habitat. This siltation also reduces the flow capacity of waterways, resulting in increased flood hazards to the public.

Other pollutants of concern during the construction process are hazardous wastes or hydrocarbons associated with the construction equipment or processes. Examples include concrete wash off, paints, solvents, and hydrocarbons from refueling operations. Poor control and handling of toxic construction materials pose an acute (short-term) or chronic (long-term) risk of death to aquatic life, wildlife, and the general public.

B. EROSION AND SEDIMENT CONTROL REQUIREMENTS

The following principles should govern erosion and sediment control practices on all sites:

1. Sediment-laden water flowing from the site shall be detained by erosion control measures appropriate to minimize sedimentation.
2. Water shall not be discharged in a manner that causes erosion at or downstream of the point of discharge.
3. All access to building sites that cross a natural watercourse, drainage easement, or swale /channel shall have a culvert of appropriate size.
4. Wastes or unused building materials, including but not limited to garbage, debris, cleaning wastes, wastewater, toxic materials, and hazardous substances shall not be carried by runoff from a site. All wastes shall be disposed of in a proper manner. No construction trash or debris shall be allowed to be placed within the permanent pool of the detention / retention ponds. If the pond is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the pond and elevations and grades have been re-established as noted in the approved plans.
5. Sediment being tracked from a site onto public or private roadways shall be minimized. This can be accomplished initially by a temporary gravel construction entrance, in addition to a well-planned layout of roads, access drives, and parking areas.
6. Public or private roadways shall be kept cleared of accumulated sediment. Bulk clearing of sediment shall not include flushing the area with water.
7. All storm drain inlets shall be protected against sedimentation with barriers meeting accepted criteria, standards, and specifications, or shall be equipped with temporary catch basin inserts. Barriers installed to protect inlets shall be cleaned and maintained in a sufficient manner and frequency to provide adequate protection while allowing adequate drainage.
8. Runoff passing through a site from adjacent areas shall be controlled

by diverting it around disturbed areas, where practical. Diverted runoff shall be conveyed in a manner that will not erode the channel and receiving areas. Alternatively, the existing channel may be left undisturbed or improved to prevent erosion or sedimentation from occurring.

9. Drainageways and swales shall be designed and adequately protected so that their final gradients and resultant velocities will not cause channel or outlet scouring.
10. All disturbed ground left inactive for fifteen (15) or more days shall be stabilized by seeding, sodding, mulching, covering, or by other equivalent erosion control measures.
11. Appropriate sediment control practices shall be installed prior to any land disturbance and thereafter whenever necessary.
12. During the period of construction activity at a site, erosion control measures necessary to meet the requirements of the Ordinance shall be maintained by the applicant.

C. COMMON CONTROL PRACTICES

All erosion control and stormwater pollution prevention measures required to comply with the Ordinance shall meet the design criteria, standards, and specifications similar to or the same as those outlined in the "Indiana Drainage Handbook" and "Indiana Handbook for Erosion Control in Developing Areas", both published by the Indiana Department of Natural Resources, or other comparable and reputable references. The Madison County Drainage Board reserves the right to deny the use of certain pollution prevention measures that may be outlined in the above references and may provide additional or alternative design criteria, standards, and specifications. Table 6-1 lists some of the more common and effective practices for preventing stormwater pollution from construction sites. Details of each practice can be found in the Indiana Drainage Handbook, the Indiana Handbook for Erosion Control in Developing Areas, or in Appendix C. These practices should be used to protect every potential pollution pathway to stormwater conveyances.

Table 6-l
Common Stormwater Pollution Control Practices for Construction Sites

Practice No.	BMP Description	Applicability	Fact Sheet
1	Site Assessment	All sites	2
2	Construction Sequencing	All sites	CN -I0l
3	Tree Preservation and Protection	Nearly all sites	1
4	Temporary Gravel Construction Entrance Pad	All sites	1
5	Wheel Wash	All sites	CN -102
6	Silt Fence	Small drainage areas	1
7	Surface Roughening	Sites with slopes that are to be stabilized with vegetation	1
8	Temporary Seeding	Areas of bare soil where additional work is not scheduled to be Performed for a minimum of 15 days	1
9	Mulching	Temporary surface stabilization	1
10	Erosion Control Blanket Surface	Temporary surface stabilization, Anchor for mulch	1
11	Temporary Diversion	Up-slope and down-slope sides of construction site, above disturbed Slopes within construction site	1
12	Rock Check Dam	2 acres maximum contributing drainage area	1
13	Temporary Slope Drain	Sites with cut or fill slopes	1
14	Straw Bale Dam	Small drainage areas	1
15	Fabric Drop Inlet Protection	1 acre maximum contributing drainage area	1
16	Basket Curb Inlet Protection	1 acre maximum contributing drainage area	1
17	Temporary Sediment Trap	5 acre maximum contributing drainage area	1
18	Temporary Sediment Basin	30 acre maximum contributing drainage area	1
19	Dewatering Structure	Sites requiring dewatering	CN -103
20	Dust Control	All sites	1
21	Spill Prevention and Control	All sites	CN -104
22	Solid Waste Management	All sites	CN -105
23	Hazardous Waste Management	All sites	CN -106

Fact sheet Location: 1. Indiana Handbook for Erosion Control in Developing Areas, 1992 or later
2. Indiana Drainage Handbook, 1999 or later

D. INDIVIDUAL LOT CONTROLS

Although individual lots within a larger development may not appear to contribute as much sediment as the overall development, the cumulative effect of lot development is of concern. From the time construction on an individual lot begins. until the individual lot is stabilized, the builder must take steps to:

1. protect adjacent properties from sedimentation;
2. prevent mud / sediment from depositing on the street;
3. protect drainage ways from erosion and sedimentation;
4. prevent sediment laden water from entering the storm sewer system;
5. prevent trash and other construction debris from leaving the building site or becoming a nuisance;
6. and, provide temporary or permanent seeding within fifteen (15) days of last construction activity.

This can be accomplished using numerous erosion and sediment control measures. A standard erosion control plan for individual lots is provided in Appendix B. The standard plan includes perimeter silt fence, stabilized construction entrance, curb inlet protection, drop inlet protection, stockpile containment, stabilized drainage swales, downspout extensions, temporary seeding and mulching, and permanent vegetation. Every relevant measure shall be installed at each individual lot site.

Construction sequence on individual lots should be as follows:

1. Clearly delineate areas of trees, shrubs, and vegetation that are to be undisturbed. To prevent root damage, the areas delineated for tree protection should be at least the same diameter as the crown.
2. Install perimeter erosion control at construction limits where drainage is expected to leave the property.
3. Install erosion control to intercept runoff prior to entering drainage swales.

4. Avoid disturbing drainage swales if vegetation is established. If drainage swales are bare, install erosion control blankets or sod to immediately stabilize the area.
5. Install protection for all inlets and catch basins on the property.
6. Install curb inlet protection, on both sides of the road, for all inlets along the property frontage and along the frontage of adjacent lots, or install temporary catch basin inserts in each inlet to be frequently cleaned.
7. Install a 2-3 inch stone or gravel construction entrance that extends from the street to the building pad or 50 feet from the street whichever is less.
8. Perform primary grading operations.
9. Contain erosion from any soil stockpiles created on-site with additional erosion control measures around the base.
10. Establish temporary seeding and mulch on disturbed areas.
11. Provide trash and construction debris storage and disposal.
12. Construct the home and install utilities.
13. Install downspout extenders once the roof and gutters have been

    constructed. Extenders should outlet to a stabilized area.
14. Seed any areas disturbed by construction and utilities installation with temporary seed mix within 3 days of completion of site disturbance.
15. Grade the site to final elevations.
16. Install permanent seeding and mulch or sod to stabilize the site.

All erosion and sediment control measures must be properly maintained throughout construction. These control measures shall remain in place until temporary or permanent vegetation is established to a coverage of seventy (70) percent over the entire disturbed area. Temporary and permanent seeding should be watered as needed until established.
Additional information concerning individual lot erosion and sediment control may be found on the "Individual Lot Erosion and Sediment Control Plan and Certification" form in Appendix B of these standards or the IDNR, Division of Soil Conservation's pamphlet titled "Erosion and Sediment Control for Individual Buildinq Sites".

Chapter Seven

POST-CONSTRUCTION WATER QUALITY BMPs

A. INTRODUCTION

Madison County has established a minimum standard that the measurement of the effectiveness of the control of stormwater runoff quality will be based on the management of Total Suspended Solids (TSS). This requirement is being adopted as the basis of the Madison County stormwater quality management program for all areas of jurisdiction.

This section of the manual establishes minimum standards for the selection and design of construction water quality BMPs. The information provided in this Chapter establishes performance criteria for stormwater quality management and procedures to be followed when preparing a BMP plan for compliance. Post-Construction BMPs must be sized to treat the water quality volume, WQv, for detention-based BMPs or the water quality discharge, Qwq, for flow-through BMPs. Chapter 8 provides the methodology for
calculating the WQv and Qwq values.

BMPs noted in this Chapter refer to post-construction BMPs, which continue to treat stormwater after construction has been completed and the site has been stabilized. Installing certain BMPs, such as bioretention areas and sand filters, prior to stabilization can cause failure of the measure due to clogging from sediment. If such BMPs are installed prior to site stabilization, they should be protected by traditional erosion control measures.

Conversely, detention ponds and other BMPs can be installed during construction and used as sediment control measures. In those instances, the construction sequence must require that the pond is cleaned out with pertinent elevations and storage and treatment capacities reestablished as noted in the accepted stormwater management plan.

B. INNOVATIVE BMPs

BMPs not previously approved by the Madison County Drainage Board, or their designated representative must be certified by a professional engineer or architect, licensed in the State of Indiana and approved by the Madison County Drainage Board, their designated representative or the Madison County Engineer. ASTM standard methods must be followed when verifying performance of new measures. New BMPs, individually or in combination, must meet the 80% TSS removal rate at 50-125 micron range (silt/fine sand) without re-entrainment and must have a low to medium maintenance requirement to be considered by the Madison County Drainage Board or their designated representative.
Testing to establish the TSS removal rate must be conducted by an independent testing facility, and not the BMP manufacturer.

C. PRE-APPROVED BMPs

The Madison County Drainage Board has designated a number of pre-approved BMP methods to be used alone or in combination to achieve the 80% TSS removal stormwater quality goals for a given project. These BMP measures are listed along with their anticipated average TSS removal rates in Table 7-1. Pre-approved BMPs have been proven/are assumed to achieve the average TSS removal rates indicated in Table 7-1. Applicants desiring to use a different TSS removal rate for these BMPs must follow the requirements discussed above for Innovative BMPs. Details regarding the applicability and design of these pre-approved BMPs are contained within fact sheets presented in Appendix D.

Note that a single BMP measure may not be adequate to achieve the water quality goals for a project. It is for this reason that a "treatment train", a number of BMPs in series, is often required for a project.

TABLE 7.1

Pre-approved Post-construction BMPs

BMP Description	Anticipated Average % TSS Removal Rate (D)	Fact Sheet	Maintenance Easement Requirements
Bioretention (A)	75	PC- 101	25 feet wide along the perimeter
Constructed Wetland	65	PC- 102	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Underground detention	70	PC- 103	20 feet wide strip from access easement to tank's access shaft & 30 feet wide along centerline of inlet and outlet
Extended Dry Detention	72	PC- 103	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Infiltration Basin (A)	87	PC- 104	25 feet wide along perimeter
Infiltration Trench (A)	87	PC- 105	25 feet wide along perimeter
Media Filtration (Underground Sand)	80	PC- 106	25 feet wide along perimeter
Media Filtration (Surface Sand)	83	PC- 106	25 feet wide along perimeter
Storm Drain Insert ©	NA (B)	PC- 107	20 feet wide strip from access easement to chamber's access shaft
Filter Strip	48	PC- 108	25 feet wide along the length on the pavement side
Vegetated Swale	60	PC- 109	25 feet wide along the top of bank on one side
Wet Pond	80	PC- 110	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet

Notes:

A. Based on capture of 0.5-inch of runoff volume as best available data. Effectiveness directly related to captured runoff volume, increasing with larger capture volumes.

B. The removal rate for this category varies widely between various models and manufacturers. Independent testing must be provided, rather than the manufacturer's testing data.

C. Must provide vendor data for removal rates.

D. Removal rates shown are based on typical results. These rates are also dependent on proper installation and maintenance. The ultimate responsibility for determining whether additional measures must be taken to meet the Ordinance requirements for site-specific conditions rests with the applicant.

Chapter Eight

METHODOLOGY FOR DETERMINATION OF REQUIRED SIZING OF BMPs

A. INTRODUCTION

Structural Water Quality BMPs are divided into two major classifications: Detention BMPs and Flow-through BMPs. Detention BMPs impound (pond) the runoff to be treated, while flow through BMPs treat the runoff through some form of filtration process.

B. DETENTION BMP SIZING

Water Quality Detention BMPs must be designed to store the water quality volume for treatment. The water quality volume, WQv, is the storage needed to capture and treat the runoff from the first one inch of rainfall. The water quality volume is equivalent to one inch of rainfall multiplied by the volumetric runoff coefficient (Rv) multiplied by the site area, or:

$$WQv = [(P)\ (Rv)\ (A)]\ /\ 12$$

where:

WQv = water quality volume (acre-feet)
P = 1 inch of rainfall
Rv = volumetric runoff coefficient
A = area in acres

The volumetric runoff coefficient is a measure of imperviousness for the contributing area and is calculated as:

$$Rv = 0.05+0.009(I)$$

where:

I is the percent of impervious cover

A proposed commercial site, for example, will be designed to drain to three different outlets, with the following drainage areas and impervious percentages:

Subarea ID	On-site Contributing Area (acres)	Impervious Area %	Off-Site Contributing Area (acres)
A	7.5	80	0.0
B	4.3	75	0.0
C	6.0	77	0.0

Calculating the volumetric runoff coefficient for subareas A, B and C yields:

Rv (subarea A) = 0.05+0.009(80) = 0.77
Rv (subarea B) = 0.05+0.009(75) = 0.73
Rv (subarea C) = 0.05+0.009(77) = 0.74

The water quality volumes for these three areas are then calculated as:

WQv (subarea A) = (1")(Rv)(A) / 12 = 0.77(7.5) / 12 = 0.48 acre-feet
WQv (subarea B) = 0.73(4.3) / 12 = 0.26 acre-feet
WQv (subarea C) = 0.74(6.0) / 12 = 0.37acre-feet

Note that this example assumed no offsite sources of discharge through the water quality detention BMPs. If there were significant sources of off-site runoff (sometimes called runoff or upstream areas draining to the site), the designer would have the option of diverting off-site runoff around the on-site systems, or the detention BMP must be sized to treat the water quality volume for the entire contributing area, including off-site sources.

C. FLOW THROUGH BMP SIZING

Flow-through BMPs are designed to treat runoff at a peak design flow rate through the system. Examples of flow through BMPs include catch basin inserts, sand filters, and grassed channels. Another flow through BMP is a dynamic separator. Dynamic separators are proprietary, and usually include an oil-water separation component.

The following procedure should be used to estimate peak discharges for flow through BMPs (adopted from Maryland, 2000). It relies on the volume of runoff computed using the Small Storm Hydrology Method (Pitt,1994) and utilizes the NRCS, TR-55 Method.

Using the WQv methodology, a corresponding Water Quality Curve Number (Cnwq) is represented as a function of percent imperviousness as shown by Figure 8-1.

The water quality curve number, CNwq, is then used in conjunction with the standard calculated time-of-concentration, tc, and drainage area as the basis input for TR-55 calculations. Using the SCS Type II distribution for 1 inch of rainfall in 24-hours, the water quality treatment rate, Qwq, can then be calculated.

REFERENCES:

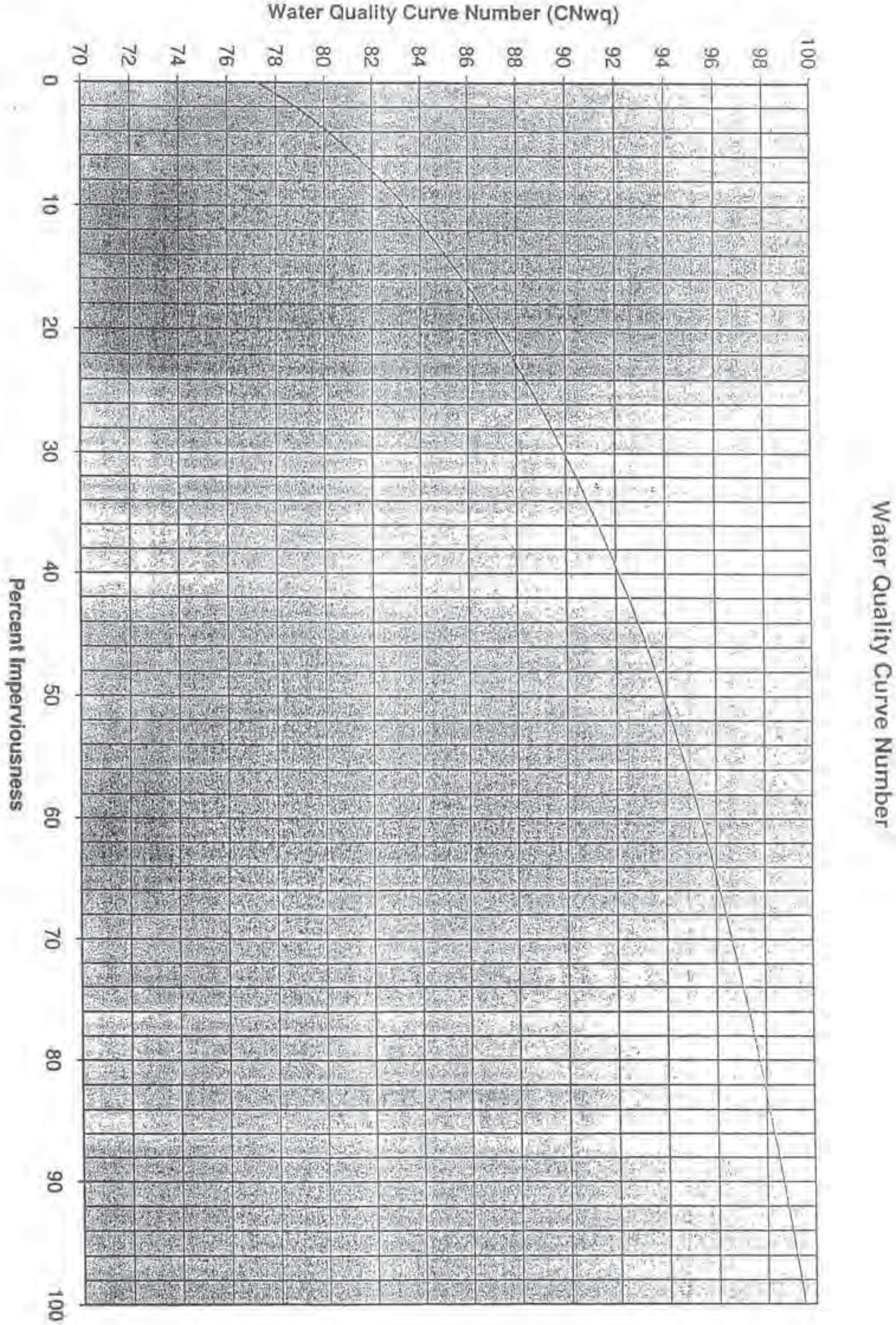
1. Maryland Stormwater Design Manual, Volume II, Appendix D.10, 2000

2. Pitt, R., 1994, Small Storm Hydrology. University of Alabama-Birmingham.
Unpublished manuscript. Presented at design of stormwater quality management practices. Madison, WI, May 17-19 1994.

3. Schueler, T. R. and R.A.Claytor,1996, Design of Stormwater Filter Systems Center for Watershed Protection, Silver Spring, MD.

4. United States Department of Agriculture (USDA), 1986. Urban Hydrology for Small Watersheds. Soil Conservation Service, Engineering Division. Technical Release 550R-55).

Figure 8-1
Curve Number Calculations for Water Quality Storm Event



Chapter Nine

PREMISES FOR THE RE-FUELING OF VEHICLES

The requirements in this section apply to all development or re-development where vehicles, equipment or tanks are re-fueled on the site, including gasoline and diesel re-fueling stations, multiple or single pump fueling maintenance facilities, or any size or type of fueling tank. Also included, are any fuel dispensing facilities transferring bulk fuels to any equipment, containers, haulers, tankers, and vehicles. Also included are any dispensing islands, pads, above and below ground storage tanks and all pumping equipment and housing. Propane tanks and re-fueling with propane is exempt from these requirements.

A. REQUIREMENTS

1. Cover: The fuel dispensing area shall be covered with a permanent canopy, roof or awning so that precipitation cannot come in contact with the fueling pad or activity area. Precipitation shall be directed from the cover to an approved storm water control.

    a. Covers ten (10) feet in height or less shall have a minimum overhang of three (3) feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated fueling activity pad and/or area it is to cover.

    b. Covers higher than ten (10) feet shall have a minimum overhang of five (5) feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated fueling activity pad and/or area it is to cover.

2. Pavement: A paved fueling pad constructed of Portland Cement Concrete shall be placed under and around the fueling activity area and shall meet all applicable building code requirements. Sizing of the paved area shall be adequate to cover the activity area, including

placement and number of the vehicles or pieces of equipment to be fueled by each pump. Fuel pumps shall be located a minimum of seven (7) feet from the edge of the fueling pad.

3. Drainage: The paved area beneath the perimeter of the cover shall be hydraulically isolated by means of grading, berms or drains to prevent un-contaminated storm water from running onto the area. Drainage from the hydraulically isolated area shall be directed to either a municipal sanitary sewer or authorized pre-treatment facility. Surrounding runoff shall be directed away from the hydraulically isolated fueling pad to a storm water control facility that meets all storm water management requirements of these standards and all other applicable laws, rules and regulations.

4. Spill Control Sump Manhole: A spill control sump manhole shall be installed on the discharge line from the fueling pad (in front of the domestic sanitary waste line connection or tie-in. The inlet to the sump manhole shall be 18 inches below the outlet from the sump manhole. An additional 60 cubic feet of storage shall be provided in the sump manhole below the inlet invert elevation to the sump manhole. This storage volume is provided for the storage of oils, greases and other solids which are to be periodically pumped and removed and properly disposed of. The spill control sump manhole is to be located on the site and not in public right of way.

5. Shut Off Valve: A shut off valve is required to be installed on the discharge line downstream of the spill control sump manhole. This valve shall be installed upstream of the domestic waste line connection.
   This valve shall be kept in a closed position and opened only to allow incidental drainage activities that do not pose a threat or risk to the disposal point system. The valve shall not be left in an open position and shall be closed immediately after the incidental drainage activities are completed.

6. Traffic Pathways: The traffic pathways that surround the fueling pads

are to be considered high-use, high-risk areas and will require a valve(s) on the outlet discharge line(s) of the storm drainage system. These valves shall be installed downstream of all applicable private stormwater quality facilities to accommodate spill containment. These valves shall be left in a open position to facilitate stormwater discharge flows during normal conditions, and immediately closed in the event of a fuel spill

APPENDIX A

ABBREVIATIONS:

ACOE	ARMY CORPS OF ENGINEERS
BFE	BASE FLOOD ELEVATIONS
BMP	BEST MANAGEMENT PRACTICE
CFR	CODE OF FEDERAL REGULATIONS
CFS	CUBIC FEET PER SECOND
CLOMR	CONDITIONAL LETTER OF MAP REVISIONS (FEMA)
CLOMR-F	CONDITIONAL LETTER OF MAP REVISIONS BASED ON FILL (FEMA)
CN	CURVE NUMBER
COE	UNITED STATES ARMY CORPS OF ENGINEERS
CSMP	COMPREHENSIVE STORMWATER MANAGEMENT PROGRAM
CSO	COMBINED SEWER OVERFLOW
CWA	CLEAN WATER ACT
ERM	ELEVATION REFERENCE MARK
E&SC	EROSION AND SEDIMENT CONTROL
EPA	ENVIRONMENTAL PROTECTION AGENCY
FBFM	FLOOD BOUNDARY AND FLOODWAY MAP
FEMA	FEDERAL EMERGENCY MANAGEMENT AGENCY
FHBM	FLOOD HAZARD BOUNDARY MAP
FIRM	FLOOD INSURANCE RATE MAP
FIS	FLOOD INSURANCE STUDY
FPG	FLOOD PROTECTION GRADE
FPS	FEET PER SECOND
GIS	GEOGRAPHICAL INFORMATION SYSTEM
GPS	GLOBAL POSITIONING SYSTEM

HGL	HYDRAULIC GRADE LINE
HUC	HYDROLOGIC UNIT CODE
IDEM	INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
INDOT	INDIANA DEPARTMENT OF TRANSPORTATION
LAG	LOWEST ADJACENT GRADE
LOMA	LETTER OF MAP AMMENDMENT (FEMA)
LOMAR	LETTER OF MAP REVISION (FEMA)
LOMR-F	LETTER OF MAP REVISION BASED ON FILL (FEMA)
MCM	MINIMUM CONTROL MEASURE
MS4	MUNICIPAL SEPARATE STORM SEWER SYSTEM
NAVD	NORTH AMERICAN VERTICAL DATUM OF 1988
NFIP	NATIONAL FLOOD INSURANCE PROGRAM
NGVD 1929	NATIONAL GEODETIC VERTICAL DATUM OF 1929
NRCS	USDA-NATURAL RESOURCE CONSERVATION SERVICE
NPDES	NATIONAL POLUTION DISCHARGE ELIMINATION SYSTEM
NPS	NON POINT SOURCE
PC	POST CONSTRUCTION
SFHA	SPECIAL FLOOD HAZARD AREA
SWCD	SOIL AND WATER CONSERVATION DISTRICT
SWPPP	STORM WATER POLUTION PREVENTION PLAN
SWQMP	STORMWATER QUALITY MANAGEMENT PLAN
Tc	TIME OF CONCENTRATION
USCS	UNIFIED SOIL CLASSIFICATION SYSTEM
USDA	UNITED STATES DEPARTMENT OF AGRICULTURE
USFWS	UNITED STATES FISH AND WILDLIFE SERVICE

APPENDIX B

DEFINITIONS

Acre-foot (AF)	A measure of water volume equal to one (1) foot of water depth over a flat acre of land. (43,560 cubic feet)
Administering Authority	The designated unit of government given the authority to issue permits.
Agricultural land Disturbing activity	Tillage, planting, cultivation or harvesting operations for the production of agricultural or nursery crops. Also includes pasture renovation and establishment, the construction and re-construction of agricultural conservation practices and the installation and maintenance of agricultural drain tiles and re-construction of open ditches.
Antecedent Runoff Condition	The index of runoff potential before a storm event. The index, developed by the Soil Conservation Service (SCS), is an attempt to account for the variation of the SCS runoff curve number (CN) from storm to storm.
Backflow Preventer	A device that allows liquids to flow in only one direction in a pipe. Backflow preventers are used on sewer pipes to prevent a reverse flow during flooding situations.
Backwater	The rise in water surface elevation usually caused by an obstruction such as a narrow bridge or culvert opening or other obstructions, which limits the area through which the water can flow.
Base Flood Elevation	The water surface elevation corresponding to a flood having a one (1) percent probability of being equaled or exceeded in a given year.
Base Flood	See "Regulatory Flood".
Base Flow	The stream discharge derived from groundwater sources as differentiated from surface runoff; sometimes considered to include flows from regulated lakes or reservoirs.
Best Management Practice	Design, construction and maintenance practices and criteria for stormwater facilities that minimize the impact of stormwater runoff rates and volumes, prevents erosion and captures pollutants.
Bioretention	A vegetated depression located on the site that is designed to collect, store and infiltrate runoff. Typically includes a mix of amended soils and vegetation. Bioretention areas or rain gardens are landscaping features adapted to provide on-site treatment of stormwater runoff. Commonly located in parking lot islands or within small pockets of residential land uses.

Board	Madison County Drainage Board
Buffer Strip	An existing or constructed, sometimes variable width strip of vegetated land intended to protect water quality and habitat.
Building	(see "structure")
Channel	A portion of a natural or artificial watercourse which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. It has a defined bed and banks, which serve to confine the water.
Channel Stabilization	Protection of the sides and bed of a channel from erosion by controlling flow velocities and flow directions using jetties, drops, or other structures and/or by lining the channel with vegetation, riprap, concrete or other suitable lining material.
Combined Sewer Overflow	A system designed and used to receive and transport combined sewage so that during dry periods the wastewater is carried to a treatment facility. During storm events, the excess water is discharged directly into a river, stream or lake without treatment.
Compensatory Storage	An artificial volume of storage within a floodplain used to balance the loss of natural flood storage capacity when artificial fill or substructures are placed within the floodplain.
Comprehensive Stormwater Management Plan	A comprehensive stormwater program for effective management of stormwater quality and quantity throughout the community.
Constructed Wetland	A manmade shallow pool that creates growing conditions suitable for wetland vegetation and is designed to maximize pollutant removal.
Construction Activity	Land disturbing activities associated with the construction of infrastructure and structures. This term does not include routine roadway side ditch maintenance, road maintenance or minor landscaping projects.
Construction Plan	A representation of a project site and all activities associated with the project. The Plan would include the location of the Project site, buildings and all other infrastructure, grading activities, schedules for implementation and all other pertinent information related to the Project site. The Storm Water Pollution Prevention Plan (SWPPP) is a part of the Construction Plan.
Construction Site Access	A stabilized stone surface access at all points of ingress / egress to the Project Site for the purpose of capturing and detaining sediment carried by tires of vehicles or other equipment entering or exiting the project site.
Contractor	An Individual or company hired or otherwise directed by the Project Developer, property owner, subcontractor or other agent associated with the development of the Project Site to perform services on the Project Site.

Control Structure	A structure designed to control the rate of flow that passes through the structure, given a specific upstream and downstream water surface elevation.
Conveyance	Any structural method for transferring stormwater between at least two points, including down spouts, pipes, ditches, channels, swales, curbs, gutters, inlets, catchbasins and any other means of transporting stormwater.
Convolution	The process of translating precipitation excess into a runoff hydrograph.
Crawl Space	The space below the first floor of a building where the excavation has not been deep enough for a basement, usually less than seven feet in depth but deep enough for access for piping, ductwork and other utilities and related equipment.
Critical Duration Analysis	The process of testing different rainfall durations to find that "critical duration" which produces the highest peak runoff or the highest storage volume.
Cubic Feet Per Second (CFS)	Mass rate of flow describing amount of stormwater passing a given point either in an open channel or pipe.
Culvert	A closed conduit used for the conveyance of surface water under a roadway or railroad or other surface flow impediment.
Curve Number (CN)	The Soil Conservation Service index number that represents the combined hydrologic effect of soil, land use, land cover, hydrologic and antecedent runoff conditions.
Dam	A barrier to confine or impound water for storage or conversion, to prevent gully erosion, or to retain soil, sediment or other runoff debris.
Datum	Any level surface or point used to measure and reference elevations (usually mean sea level).
Depressional Storage Areas	Non-riverine depressions on the earths surface where stormwater collects. The volumes are often referred to in units of "acre-feet".
Design Storm	A selected storm event, described in terms of the probability of occurring one time within a given number of years, for which rainfall events are measured and flood control measures are designed and built.
Designated Representative	A Person(s) or Firm named by the Madison County Drainage Board to act in their behalf on drainage matters which come under the Board's jurisdiction. The Person(s) or Firm would include, but not necessarily limited to: Licensed Engineers, Licensed Land Surveyors, the Madison County Highway Engineer, the Madison County Planning Director, the Madison County Surveyor and the Madison County Drainage Board Attorney.
Detention	Managing stormwater runoff by temporarily holding and managing a controlled release.
Detention Basin	A facility constructed or modified to restrict the flow of storm water to a prescribed maximum rate, and to detain concurrently the excess waters that accumulate behind the outlet.
Detention Facility	A facility designed to detain a specified amount of stormwater runoff assuming a specified release rate. The volumes are generally referred to in units of acre-feet.

Detention Storage	The temporary detaining of stormwater in storage facilities, on rooftops, in streets, parking lots, school grounds, parks, open spaces or any other area pre-determined and under controlled conditions, with the release rate controlled and regulated by appropriately installed control devices.
Detention Time	The theoretical time required to displace the contents of a detention holding facility at a given rate of discharge (detention time = volume divided by rate of discharge).
Developer	Any person(s) or firm financially responsible for construction activity, or an owner of property who sells or leases or offers for sale or lease any parcels of land.
Development	Any man-made change or improvement to either improved or un-improved real estate including but not limited to: 1. Construction, re-construction, or placement of a building or any building addition. 2. Construction of flood control structures such as levees, dikes dams or channel improvements and regulated drain improvements. 3. Construction or reconstruction of bridges or culverts. 4. The installation of manufactured homes or buildings on a site; preparing a site for a manufactured home or building, or preparing a site for the placement of a recreational vehicle. 5. The installation of utilities including tile drains and storm sewers, installation of walls, construction of roads, or similar projects. 6. Mining, dredging, filling, grading, excavation, or drilling operations. 7. Installation of communication towers; wind powered electric generating towers. 8. Any outside storage of equipment or materials. 9. Any other activity that might change the direction, height, quantity or velocity of flood or surface waters. "Development" does not include activities such as the maintenance of existing buildings and facilities such as painting, re-roofing, the re-surfacing of streets and roads, gardening, plowing, and similar agricultural practices that do not involve grading, filling, or excavation.
Direct Release	A method of stormwater management where runoff from a part of the entire development is released directly to the receiving stream without providing detention.
Discharge	Usually the rate of water flow. The volume of water passing a given point per unit of time.
Disposal	The discharge, deposit, injection, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that the solid waste or hazardous waste or any constituent of the waste may enter the environment, emitted into the air, or be discharged into any waters.
Ditch	A manmade or natural open drainage way in or into which excess surface water or groundwater drained from land, stormwater runoff, or floodwaters flow either continuously or intermittently.
Drain	Either open channel or closed conduit for carrying off surplus groundwater or

surfacewater.

Drainage	The removal of excess surface water or groundwater from land by means of ditches or subsurface drains.
Drainage Area	The watershed area draining into a stream or open ditch to a given point on the stream or ditch. The area may be different sizes for surface runoff and subsurface flow. Usually the surface flow boundaries define the drainage area.
Drainage Board	The Board established in each county by IC 36-9-27-4 acting herein as the "Madison County Drainage Board" having authority over the "Regulated Drains" of the county.
Dry-Bottom Detention Basin	A basin designed to be completely dewatered after having provided it's designed detention of surface water runoff during a storm event.
Duration	The time period of a rainfall event.
Elevation Certificate	The form created by the Federal Emergency Management Agency used to certify the 100-year or base flood elevation and the lowest elevation of usable space to which a building has been constructed (i.e. crawl space, basement).
Elevation Reference Mark (ERM)	The elevation benchmark tied to the National Geodetic Vertical Datum of 1929 and identified during the preparation of a Flood Insurance Study prepared for the Federal Emergency Management Agency.
Emergency Spillway	A vegetated or hard surfaced channel used to safely convey flood discharges around an impoundment structure.
Energy Dissipater	A device placed to reduce the energy (velocity) of flowing water.
Engineer	An individual licensed by the State of Indiana for the practice of Engineering.
Erosion	The wearing away of the land surface by water, wind, ice, gravity, or other geological forces. Terms used to describe different types of water erosion are: 1. Accelerated Erosion; erosion occurring more rapidly than normal usually caused as a result of the activities of man. 2. Channel Erosion; an erosion process whereby the volume and velocity of flow wears away the bed and/or banks of a well-defined channel. 3. Gully erosion; an erosion process whereby runoff water accumulates in narrow channels and over relatively short periods, removes the soil to considerable depths ranging from 1 to 2 feet to 75 to 100 feet. 4. Rill Erosion; an erosion process in which numerous small channels only inches deep are formed, occurring mainly on recently disturbed and exposed soils. 5. Splash Erosion; the spattering of small soil particles caused by the impact of raindrops on wet soils; the loosened and spattered particles may or may not be subsequently removed by surface runoff. 6. Sheet Erosion; the gradual removal of a fairly uniform layer of soil from the land surface by runoff water.
Erosion & Sediment Control Measure	A practice or a combination of practices to control erosion and the resulting sedimentation and/or off site damages.
Erosion & Sediment	The use of appropriate erosion and sediment control measures to minimize

Control System	sedimentation by first reducing or eliminating erosion at the source and then as Necessary, trapping sediment to prevent it from being discharged from a project site.
Erosion Control Plan	A written description and site plan of pertinent information concerning erosion control measures designed to meet the requirements of the Ordinance and Standards.
Extended Dry Detention	A dry detention basin that has been designed to increase the length of time that storm water will be detained, typically between 24-48 hours, to allow sediment particles and associated pollutants to settle out.
Farm or Field Tile	A pipe installed in an agricultural area to provide for subsurface drainage of farmland for agricultural crop production.
FEMA	The Federal Emergency Management Agency.
Filter Strip	Usually a long narrow strip of land (20 to 100 feet in width) of undisturbed or planted vegetation used adjacent to disturbed or impervious surfaces to filter stormwater pollutants for the protection of watercourses, reservoirs or adjacent properties.
Final Stabilization	The establishment of permanent vegetation cover or the application of a permanent nonerosive material to areas where all land disturbing activities have been completed and no additional land disturbing activities are planned under the permit.
Flood (flood waters)	A general and temporary condition of partial or complete inundation of normally dry land areas from the overflow, the unusual and rapid accumulation, or the runoff of surface waters from any source.
Flood Boundary & Floodway Map (FBFM)	A map prepared by the Federal Emergency Management Agency, which depicts the FEMA designated floodways within a community. This map also includes delineation of the 100-year and 500-year floodplain boundaries and the location of the Flood Insurance Study cross-sections.
Flood Crest	The maximum stage or elevation reached or expected to be reached by the waters of a specific flood at a given time.
Flood Duration	The length of time a stream is above flood stage or overflowing its banks.
Flood Easement	Easement granted to identify the areas inundated by the 100-year flood and prohibit or severely restrict development activities.
Flood Elevation	The elevation of all locations delineating the maximum level of high waters for a flood of a given return period.
Flood Frequency	A statistical expression of the average time period between floods equaling or exceeding a given magnitude. Example: A 100-year flood has a magnitude expected to be equaled or exceeded on the average of once every one hundred years; such a flood has a one-percent chance of being equaled or exceeded in any given year.
Flood Hazard Area	Any floodplain, floodway, floodway fringe, or any combination thereof, which is subject to inundation by the regulatory flood; or any flood plain as delineated by

	Zone A on a Flood Hazard Boundary Map.
Flood Hazard Boundary Map (FHBM)	A map prepared by the Federal Emergency Management Agency that depicts Special Flood Hazard Areas as a zone A within a community. There are no study text, base flood elevations, or floodways associated with this map.
Flood Insurance Rate Map (FIRM)	A map prepared by the Federal Emergency Management Agency that depicts Special Flood Hazard Areas within a community. This map also includes the 100-year or Base Flood Elevation at various locations along the watercourse. More recent versions of the FIRM may also show the FEMA designated floodway boundaries and the location of the Flood Insurance Study cross-sections.
Flood Insurance Study (FIS)	A study prepared by the Federal Emergency Management Agency to assist a community participating in the National Flood Insurance Program in it's application of the program regulations. The study consists of a text which contains community background information with respect to flooding, a floodway data table, summary of flood discharge, flood profiles, a Flood Insurance Rate Map, and a Flood Boundary and Floodway Map.
Floodplain	The channel proper and the areas adjoining the channel which have been or hereafter may be covered by the regulatory or 100-year flood. Any normally dry land area that is susceptible to being inundated by water from any natural source. The floodplain includes both the floodway and the floodway fringe districts.
Floodplain Regulations	General term applied to the full range of codes, ordinances and other regulations relating to the use of land and construction within floodplain limits. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws and open area (space) regulations.
Flood Protection Grade (FPG)	The elevation of the regulatory or 100-year flood plus two (2) feet at any given location in the Special Flood Area or 100-year floodplain. Also the elevation of the lowest floor of a building, including the basement and crawl space, which shall be two (2) feet above the elevation of the regulatory flood.
Flood Storage Areas	Depressions, basins, or other areas that normally stand empty or partially empty, but fill with rainfall runoff during storms to hold the runoff and reduce downstream flow rates. The volumes are often referred to in units of acre-feet.
Floodway	The channel of a river or stream and those portions of the adjoining floodplains which are reasonably required to efficiently carry and discharge the peak flow of the regulatory flood.
Floodway Fringe	That portion of the floodplain lying outside the floodway, which is inundated by the regulatory flood.
Footing Drain	A drainpipe installed around the exterior of a basement wall or crawl space foundation to relieve water pressure caused by high ground water elevation.
Forebay	A small pond placed in front of a larger retention/detention system such as a wet pond, dry pond, or wetland to intercept and concentrate a majority of sediment coming into the system before the sediment reaches the primary retention/detention system or outlet structures.
Freeboard	An increment of height added to the base flood elevation to provide a factor of safety for uncertainties in calculations, unknown local conditions, wave actions and unpredictable effects such as those caused by ice or debris jams.

French Drain	A drainage trench backfilled with a gradation of aggregate, with sufficient voids suitable for transmitting water; sometimes containing a perforated pipe.
Gabion	An erosion control structure consisting of a rectangular wire cage basket or baskets filled with graded stone or rock.
Gaging Station	A selected section of a stream channel equipped with a gage, stage recorder, or other facilities for determining stream stage and discharge.
Geotextile Fabric	A woven or non-woven, water-permeable synthetic material used to trap sediment particles, prevent the clogging of aggregates with fine-grained soil particles, or act as a separator under road aggregates.
Geotextile Liner	A synthetic, impermeable fabric used to seal impoundments against leaks.
Grade	(1) The inclination or slope of a channel, conduit, etc., or natural ground surface usually expressed in terms of the percentage the vertical rise or fall bears to the corresponding horizontal distance. (2) The finished surface of a ditch bed, road bed, top of embankment, or bottom of excavation; any surface prepared to a design elevation for the support of construction, such as paving or laying of pipe. (3) To finish the surface of a swale or ditch bed, roadbed, top of embankment, or bottom excavation, or other land area to a smooth, even condition.
Grading	The cutting and filling of the land surface to a desired slope or elevation.
Grassed Waterway	A natural or constructed waterway of usually narrow width, usually long and shallow, covered with erosion resistant grasses.
Groundwater	Accumulation of underground water, natural or artificial. The term does not Include man-made underground storage or conveyance structures.
Habitat	The environment in which the life needs of plant and/or animal are supplied.
Hard Surface	See "Impervious Surface".
High Water	The maximum designed, permitted, or regulated water level for an impoundment.
Hydraulics	A branch of science that deals with the practical application of the mechanics of water movement. A typical hydraulic study is undertaken to calculate water surface elevations.
Hydraulic Grade Line (HGL)	The HGL is equal to the water surface grade for open channel and gravity pipe flow.
Hydrograph	A graph depicting either the discharge, stage depth, velocity, or volume of water With respect to time for a given point on a stream, drainage basin, or lake.
Hydrometerologic	Water-related meteorological data such as rainfall or runoff.
Hydrostatic Loads	Those loads or pressures resulting from the static mass of water at any point of Groundwater or floodwater contact with a structure. They tend to be equal in all directions and always act perpendicular to the surface to which they are applied. Hydrostatic loads can act vertically on structural members such as floors and

	decks and can act laterally on vertical structure members such as walls, piers, and foundations.
IDNR	Indiana Department of Natural Resources.
Impact Areas	Areas defined or mapped that are unlikely easily drained because of one or more factors, including but not limited to, any of the following: soil type, topography, land where there is no adequate outlet, a floodway or a floodplain, land within 75 feet of each bank of any Regulated open drain or 75 feet from the centerline of any Regulated tile drain.
Impervious Surface	Surfaces, such as gravel and stone drives and parking areas, hard surface concrete and asphalt pavements and rooftops, which prevents the infiltration of stormwater into the soil.
Individual Building Lot	A parcel of land, approved as a single building site by local ordinances.
Individual Lot Operator	A contractor or subcontractor working on an individual building lot.
Individual Lot Owner or Agent	A person who either owns the individual lot or who has authority to act as agent for the Owner of the Individual Lot.
INDOT	Indiana Department of Transportation. Generally used herein to refer to the INDOT Standard Specifications.
Infiltration	Passage or movement of water into the soil.
Infiltration Practices	Any structural BMP designed to facilitate the percolation of runoff through the soil to ground water. Examples include infiltration basins or trenches, dry wells and porous pavements.
Infiltration Basin	A shallow impoundment designed to infiltrate stormwater into the soil.
Infiltration Swale	A depressed shallow ditch designed to promote infiltration.
Intermittent Stream	A stream that has water only during wet periods, especially after storm events.
Invert	The inside bottom of a pipe or structure.
Land-Disturbing Activity	Any man-made change to the land surface, including removing vegetative cover that exposes the underlying soils, any excavations, fills, or grading.
Land Surveyor	A person licensed under the laws of the State of Indiana to practice land surveying.
Low Entry Elevation	The elevation in the structure where flooding can enter the structure.
Lowest Adjacent Grade	The elevation of the lowest grade adjacent to a structure where the soil meets the foundation around the outside of the structure (including basement walkouts, patios, decks, porches, support posts or piers, and rims of window wells.
Lowest Floor	Refers to the lowest of the following: 1. The top of the basement floor.

2. The top of the garage floor, if the garage floor is the lowest level of the building.
3. The top of the first floor of buildings constructed on a concrete slab or of buildings elevated on pilings or constructed on a crawl space with permanent openings.
4. The top of the floor of any enclosure below an elevated building where the walls of the enclosure provide any resistance to the flow of flood waters unless:
    a. The walls are designed to automatically equalize the hydrostatic flood forces on the walls by allowing for the entry and exit of flood waters, by providing a minimum of two (2) openings (in addition to doorways and windows) having a total area of one (1) square foot for every two (2) square feet of enclosed area subject to flooding. The bottom of all such openings shall be no higher than one (1) foot above grade.
    b. Such enclosed space shall be usable only for the parking of vehicles or building access.

Major Drainage System	Drainage system carrying runoff from an area of one or more square miles.
Manning Roughness Coefficient i.e. Manning's "n" Value	A dimensionless coefficient "n" utilized in the "Manning's Equation" to account for channel or pipe wall frictional losses in steady uniform flows.
Measurable Storm Event	A precipitation event that results in a total measured precipitation accumulation equal to or greater than, one-half (0.5) inch of rainfall.
Media Filtration	A two-stage constructed treatment system that includes a pre-treatment settling basin and filtration bed containing sand or other filter media.
Minimum Control Measures	Minimum measures required by the NPDES Phase II program. The six (6) MCMs are: Public education and outreach; Public participation and involvement; Illicit discharge, detection and elimination; Construction site runoff control; post construction runoff control; and Pollution prevention and good housekeeping.
Minor Drainage System	A drainage system carrying runoff from an area less than one square mile.
Minor Subdivision	See Subdivision, Minor
Mulch	A natural layer of plant residue or other artificial materials used to cover the soil surface; usually at a minimum uniform density of 70% across the entire disturbed area, which when in place conserves moisture, holds soils in place, aids in establishing plant cover, and minimizes temperature fluctuations.
Municipal Separate Storm Sewer System	A Municipal Separate Storm Sewer System (MS4) meets all the following criteria: (1) is a conveyance or system of conveyances owned by the state, county, city, town, district, or other entity public or private; (2) discharges to waters of the United States; (3) is designed or used for collecting or conveying stormwater; (4) is not a combined sewer; and (5) is not part of a Publicly Owned Treatment Works (POTW).
Mutual Drain	A drain that, at the time of installation, was established by the mutual consent of all of the then affected landowners.

National Flood Insurance Program (NFIP)	The NFIP is a federal program enabling property owners to purchase flood insurance. The Federal Emergency Management Agency administers the NFIP in communities throughout the United States. The NFIP is based on an agreement between local communities and the Federal Government which states that if a community will implement floodplain management measures to reduce future flood risks to new construction, and substantially improve structures in flood hazard areas, the Federal Government will make flood insurance available within the community as a financial protection against flood losses that do occur.
National Geodetic Vertical Datum of 1929	The nationwide Federal Elevation Datum used to reference topographic elevations to a known value.
National Pollution Discharge Elimination System (NPDES)	A permit developed by the United States Environmental Protection Agency through the "Clean Water Act" (CWA) covering requirements of municipal stormwater quality; administered by the Indiana Department of Environmental Management.
Natural Drainage	The flow patterns of stormwater runoff over the land in it's pre-developed or natural state.
Non-agricultural Land Use	Commercial, residential, industrial or other land use not used for agricultural production.
Non-Point Source Pollution	Pollution that enters a water body from diffuse origins on the watershed and does not result from discernable, confined, or discrete conveyances.
Normal Depth	The depth of flow in pipes or open channels during given uniform flow conditions.
North American Vertical Datum of 1988 (NAVD 1988)	The nationwide, Federal Elevation Datum used to reference topographic elevations to a known value.
Nutrient(s)	Substances necessary for the growth and reproduction of organisms. In water, those substances, chiefly nitrates and phosphates, that promote growth of algae and bacteria.
Off-Site	That which is not located within the bounds of the subject project site.
Off-Site Contributing Water Shed	Those land areas, by virtue of existing topography, which shed and contributes surface water runoff onto or through the subject developing site.
On-Site	Confined within the bounds of the subject project site.
100-year Frequency Flood	See "Regulatory Flood"
Open Drain	A natural watercourse or man-made open channel that conveys water.
Open Space	Any land area devoid of any disturbed or impervious surfaces created by man-made activities such as residential, commercial, industrial, agricultural or other land disturbing activities.
Orifice	A devise which controls the rate of water flow.

Outfall	The point, structure, or location where a pipe or open drain discharges to a receiving body of water.
Outfall Scouring	The deterioration of a streambed or lakebed from an outfall discharge to the extent that streambed material is removed by the discharge.
Outlet	The point of water disposal from a pipe, stream, river or lake.
Overland Flow	Sheet flow or shallow concentrated flow.
Peak Discharge or Peak Flow	The maximum instantaneous flow from a given storm condition at a specific location.
Percolation	The movement of water through soil.
Perennial Stream	A stream that maintains water in its channel throughout the year.
Permanent Stabilization	The establishment, at a uniform density of 75% across the disturbed area, of vegetative cover or permanent non-erosive material that will ensure the resistance of the soil to erosion, sliding, or other movement.
Permeability (soil)	The quality of a soil that enables water or air to move through it, usually expressed in inches per hour or day.
Pervious	Allowing movement of water.
Phasing of Construction	Sequential development of smaller portion(s) of a larger project site.
Plat of Survey	A scaled diagram, prepared by a licensed Land Surveyor, indicating the boundary dimensions of the subject tract of land or subdivision, accompanied by a legal description of the tract.
Point Source	Any discernable, confined, and discrete conveyance including but not limited to any pipe, ditch, channel, or any other container from which pollutants are or maybe discharged.
Porosity	The volume of voids or pore space in soils or rock.
Porous Pavement	A type of pavement allowing stormwater to percolate or to be passed through to underlying materials and soils, the purpose of which is to reduce the quantity of runoff.
Private Drain	A drain originally constructed privately by a landowner for the purpose of draining that landowner's property or a portion thereof. The drain may lie on more than one landowner's property.
Professional Engineer	A person licensed under the laws of the State of Indiana to practice Engineering.
Programmatic Indicator	Any data collected by an MS4 entity that is used to indicate implementation of one or more minimum control measures.
Project Site	The entire area on which construction activity is to take place.

Project Site Owner	The person(s) including agents for the owner(s) for the purpose of this definition required to submit a stormwater permit application, and be required to comply with the terms of the Madison County Drainage Ordinance and Standards, including the Developer or person(s) having financial and/or operational control of project plans, specifications and any construction activities, including having the ability to make modifications or alterations to those plans and specifications.
Probable Maximum Flood	The most severe flood that may be expected from a combination of the most critical meteorological and hydrological conditions that are reasonably possible to occur in the drainage basin. Used to design high-risk flood protection works and sitting of structures and facilities that shall be subject to almost no risk of flooding. The probable maximum flood is usually much larger than the 100-year flood.
Publicly Owned Treatment Works (POTW)	A municipal operation that breaks down and removes contaminants in the wastewater prior to discharging to a stream through primary and/or secondary treatment systems.
Qualified Professional	An individual who by training and experience in stormwater management and/or treatment and related fields who is licensed or certified by the State of Indiana.
Rain Garden	A vegetative practice used to alter either impervious surfaces, such as roofs or other land areas for the purpose of absorption and treatment of rainfall.
Rainfall Intensity	The rate at which rain is falling at any given instant, usually expressed in inches per hour.
Reach	The length of storm drain, stream or river.
Receiving Stream or Receiving Water(s)	The body of water into which runoff or effluent is discharged. The term does not include private drains, retention or detention basins or constructed wetlands utilized for treatment.
Recharge	The replenishment of groundwater reservoirs by infiltration and transmission from the outcrop of an aquifer or from permeable soils.
Recurrence Interval	A statistical expression of the average time between floods equaling or exceeding a given magnitude.
Redevelopment	Alterations of property that change a site or building(s) in such a way that there is disturbance of one (1) acre or more of land.
Regulated Area	All areas within the jurisdictional boundaries of Madison County.
Regulated Drain	Open or tile drains or a combination of both subject to the provisions of the Indiana Drainage Code, (I.C. 36-9-27) as administered by the Madison County Drainage Board or any Joint Drainage Board of which Madison County is a part.
Regulatory Flood or 100-year Flood	The discharge and/or elevation associated with the 100-year flood as calculated by a method and procedure, which is acceptable to and approved by the Indiana Department of Natural Resources and the Federal Emergency Management Agency. The "Regulatory Flood" is also

known as the "Base Flood".

Regulatory Floodway	See "Floodway"
Release Rate	The amount of stormwater released from a stormwater control facility. Usually measured in cubic feet per second.
Reservoir	A natural or artificially created pond, lake or other impoundment space used for the storage, regulation and/or control of water, and may be either permanent or temporary. The term is also used in the hydrologic modeling of storage facilities.
Retention	The storage of stormwater to prevent it from leaving the development site and may be temporary or permanent.
Retention Basin	A type of water storage that has no positive outlet, used to retain stormwater runoff for an indefinite amount of time. Stored runoff from this type of basin is removed only by infiltration through a porous bottom or by evaporation.
Retention Facility	A runoff storage area designed to completely retain a specified amount of stormwater runoff without release except by means of infiltration, evaporation or pumping. The volumes are generally referred to as acre-feet.
Return Period	The average interval of time within which a given rainfall event will be equaled or exceeded. A flood having a return period of 100 years has a one percent probability of being equaled or exceeded in any one given year.
Revetment	The facing with stone or other materials, either permanent or temporary, placed along the stream banks to stabilize the banks and protect them from erosive actions.
Right-of-Way for Regulated Drains	The statutory right-of-ways for Regulated tile and open Drains as defined in the Indiana Drainage Code (I.C.36-9-27)
Riparian Habitat	A land area adjacent to a waterbody that supports animal and plant life associated with that waterbody.
Riparian Zone	Of, on or pertaining to the banks of a stream, river or pond.
Riprap	Graded and/or broken rock, cobble or boulders placed on the banks or slopes of streams and ponds, for the protection against erosion.
River Restoration	Restoring the river, stream or ditch to its perceived original non-obstructed capacity by means of clearing, snagging, obstruction removal, silt removal, and stream bank protection measures. The term "restoration" as noted does not necessarily imply restoration or improvement of water quality or habitat within the channel or its adjacent areas.
Riverine	Relating to, formed by, or resembling a stream (including creeks and rivers).
Runoff	That portion of precipitation that flows from a drainage area on the land surface, in open channels, or in stormwater conveyance systems.

Runoff Coefficient	A decimal fraction relating the amount of rain which appears as runoff and reaches the storm drain system to the total amount of rain falling. A coefficient of 0.5 implies that 50 percent of the rain falling on a given surface appears as storm water runoff.
Scour	The clearing and digging action of flowing water.
Sediment	Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest either temporarily or permanent on the earth's surface.
Sediment Forebay	A small pond placed up-stream or in front of a larger retention/detention facility such as a wet or dry pond, or wetland to intercept and concentrate a majority of sediment that is coming into the system before it reaches the larger facility.
Sedimentation	The process that deposits soils, debris and other unconsolidated materials either on the ground surface or in bodies of water or watercourses.
Seepage	The passage of water or other fluid through a porous medium, such as the passage of water through an earth embankment or masonry wall.
Settling Basin (Silt Basin)	An enlargement and/or deepening of a portion of the stream channel or pond to permit the settling of soil and debris carried in suspension.
Silt	A soil type consisting of particles between 0.002 and 0.05 mm in diameter, also a soil textural class indicating more than 80% silt.
Silt Fence	A low height barrier fence, of either burlap or synthetic fabric, placed around the perimeter of a construction area to trap and retain on-site sedimentation during rainfall or other construction activities.
Siphon	A closed conduit or portion of which lies above the hydraulic grade line, resulting in a pressure less than atmospheric and requiring a vacuum within the conduit to start the flow.
Site	The entire included in the legal description of the land on which land disturbing activities are to be performed.
Slope	The degree of deviation of a surface from the horizontal, measured as a numerical ratio or percent i.e. a slope of 2 to 1 (2:1) would mean 2 units horizontal and 1 unit vertical or a 50% slope.
Soil	The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.
Soil and Water Conservation District	A public organization created under state law as a special purpose district to develop and carry out a program of soil, water and related resource conservation, use and development within its boundaries. A subdivision of state government with a local governing body, established under I C 14-32.
Special Flood Hazard Area	An area that is inundated during the 100-year flood.

Spillway	A waterway in or about a hydraulic structure for the escape of excess water.
Stilling Basin	A basin used to slow water down or dissipate its energy.
Storage Practices	Any structural BMP intended to store or detain stormwater and slowly release it to receiving waters or drainage systems. The term includes retention and detention systems.
Storm Drain Markings	Any marking procedure that identifies a storm sewer inlet, catch basin, manhole or other structure as draining directly to a receiving waterbody. The procedure can include painted, cast, or adhesive messages.
Storm Duration	The length of time that water may be stored in any stormwater control facility, computed from the time water first begins to be stored.
Storm Event	An estimate of the expected amount of precipitation within a given period of time.
Storm Frequency	The time interval between storms of predetermined intensity and volumes of runoff (e.g. a 5-year, 10-year, or 100-year storm).
Storm Sewer	A closed conduit for conveying collected storm water, while excluding sewage and industrial wastes. Also called a storm drain.
Stormwater	Water resulting from rain, snow, sleet, hail and ice melt.
Stormwater Drainage System	All means, natural or man-made, used for transporting stormwater to, through, or from a drainage area to and through any of the following: conduits and appurtenant features, channels, canals, rivers, streams, ditches, swales, culverts, pumping stations, and storage facilities.
Stormwater Facility	All rivers, streams, ditches, channels, swales, conduits, sewers, tiles, ponds, levees, detention/retention areas, natural and man-made impoundments, wetlands, and any other natural or artificial means of draining surface and subsurface water from the land.
Stormwater Pollution Prevention Plan	A plan developed to minimize the impact of stormwater pollutants resulting from construction activities.
Stormwater Quality Management Plan	A comprehensive written document that addresses stormwater runoff quality.
Stormwater Quality Measure	A practice, or a combination of practices, to control or minimize pollutants associated with storm water runoff.
Stormwater Runoff	The water derived from rains falling within a tributary basin, flowing over the surface of the ground or collected in conduits or channels.
Stream	See Intermittent Stream, Perennial Stream, or Receiving Stream.
Stream Banks	The usual boundaries (not the flood boundaries) of à stream channel. Right and left banks are named facing downstream.

Stream Length	The length of the blue or purple line depicting a stream or ditch on the United States Geological Survey seven and one-half (7-1/2) minute topographic quadrangle map.
Stream Restoration	See River Restoration
Strip Development	A multi-lot project where building lots front on an existing roadway.
Structure	Refers to an object either above or below ground, including manholes, catchbasins, inlets, drop basins, pumping stations, buildings, bridges, pre-manufactured homes, and storage tanks.
Subarea	That portion of the watershed divided into a homogenous drainage unit, which can then be modeled for purposes of determining runoff rates. The subareas would have distinct boundaries as defined by the topography of the area.
Subbasin	See Subarea
Subdivision	Any land that is divided or proposed to be divided into lots, whether contiguous or not, subject to zoning requirements, for the purpose of sale or lease and as a part of a larger common plan of development or sale.
Subsoil	The B-horizon of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below which roots do not normally grow.
Subsurface Drain	A trench containing a perforated pipe, usually protected by a filter fabric, backfilled with pervious washed gravel or washed stone, for intercepting groundwater.
Subwatershed	See Subarea
Sump Pump	A pump that discharges seepage from foundation footing drains.
Surcharge	The backup of water in a sewer system in excess of the design capacity of the system.
Surface Runoff	Precipitation that flows onto the surfaces of roofs, parking lots, drives, streets, the ground, etc., and is not absorbed or contained by that surface, and accumulates and runs off.
Swale	An elongated depression in the land surface either natural or man-made, vegetated, that generally is only seasonally wet or wet only during storm events, conducting stormwater into primary drainage channels or conduits, providing limited detention and groundwater recharge.
Tailwater	The water surface elevation at the downstream end of a hydraulic structure (i.e. culvert, pipe, weir, dam, etc.).
Temporary Stabilization	The covering of soil to ensure its resistance to erosion, sliding, or other movement. The term includes vegetative cover, anchored mulch, or other non-erosive materials applied at a uniform density of 75% across the disturbed area.
Thalweg	The deepest point or center of a channel.

Tile Drain	Pipe made of clay, concrete, solid or perforated plastic or other material laid to a designed grade and depth, to collect and carry excess water from the soil.
Tile Drainage	Land drainage by a series of tile drains laid at a specified depth and spacing, outleting into a channel or major drainage system.
Time of Concentration (tc)	The travel time of a particle of water from the most hydraulically remote point in the contributing area to the point under study. This can be the sum of overland flow, shallow concentrated flow, flow in street gutters, storm sewers, and drainage channels.
Topographic Map	Geographic representation of the topographic features of a land area, showing both the horizontal distance between the features and their elevations relative to a given datum.
Topography	The representation of a portion of the earth's surface showing natural and man-made features of a specific locality such as rivers, streams, lakes, roads and most importantly, variations in ground surface elevations of the area.
Topsoil	(1) The dark colored surface layer, or a horizon of soil; when present it ranges in depth from less than inch to two (2) or three (3) feet in depth. (2) Sometimes equivalent to the plow (depth) layer of cultivated soils. (3) Commonly used to refer to the surface layer(s) enriched in organic matter and having textural and structural characteristics favorable for plant growth.
Total Maximum Daily Load	Method used to establish allowable loadings for specified pollutants in a surface water resource to meet established water quality standards.
Toxicity	The characteristic of being poisonous or harmful to plant or animal life.
TP-40 Rainfall	Design storm rainfall depth data for various durations published by the National Weather Service in their "Technical Paper 40" dated 1961.
Tributary	Based on the size of the contributing drainage area, a smaller watercourse that flows into a larger watercourse.
Turbidity	The measure of the suspended solids in a liquid causing cloudiness of the liquid.
Underdrain	A small diameter perforated pipe that allows the bottom of the swale and/or detention basin to drain down.
Unified Soil Classification System	A system of classifying soils based on particle size, gradation, plasticity index, and liquid limit.
Uniform Flow	A state of steady flow when the mean velocity and the cross sectional area remain constant in all sections of a reach.
Unit Hydrograph	The hydrograph that results from one inch of precipitation excess generated uniformly over the watershed at a uniform rate during a specified period of time.

Urban Drain	A drain either tiled or open or a combination of both classified and defined by the Indiana Drainage Code (I C 36-9-27).
Vegetative Practices	Any structural or non-structural BMP that, with optimal design and good soil conditions, utilizes various forms of vegetation to enhance pollutant removal, maintain and improve natural site hydrology, promote healthier habitats, and increase aesthetic appeal. Examples include, grassed swales, filter strips, buffer strips, constructed wetlands, and rain gardens.
Vegetative Stabilization	The protection of erodible or sediment producing areas with: permanent seeding producing long term vegetative cover, short term seeding producing temporary vegetative cover, or sodding producing areas covered with a turf of perennial sod-forming grasses.
Vegetated Swale	A type of shallow-channel stormwater conveyance vegetated to filter stormwater and prevent erosion.
Waterbody	Any accumulation of water, surface or underground, natural or artificial.
Watercourse (Water Course)	Any river, stream, ditch, creek, brook, branch, either natural or man-made drainage way in or into which stormwater runoff or floodwaters flow either regularly or intermittently.
Watershed	The area drained by or contributing water to a specific point defined by topographic elevations.
Watershed Area	All land confined by topographic elevation, shedding water to a given point.
Water Quality	A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water Resources	The supply of groundwater and surface water in a given area.
Water Table	The free surface of ground water usually below ground, subject to ground and atmospheric pressures, rising and falling with the rainfall and seasons or from other conditions such as withdrawal.
Waterway	Either a natural or man-made channel or swale used for the conveyance of water.
Weir	A channel or pipe spanning device for measuring or regulating the flow of water.
Wet-Bottom Detention Basin	A storage basin designed to retain a permanent pool of water below the elevation of the designed storage capacity after having provided its planned detention of runoff during the storm event.
Wet Pond	Either a natural or constructed basin that has a permanent pool of water throughout the year or wet season. The pond treats the incoming stormwater runoff by allowing particles to settle and algae to take up nutrients.
Wetlands	Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support and under normal

circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions.

APPENDIX C

CONSTRUCTION BMPs

BMP CN - 101

CONSTRUCTION SEQUENCING

DESCRIPTION

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sediment control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided. Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff and vehicle tracking.

ADVANTAGE

1. Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site venerable to accelerated erosion. Construction procedures that limit land clearing, provide timely installation of erosion and sedimentation controls and restore protective cover quickly can significantly reduce the erosion potential of a site.

DESIGN CRITERIA

1. Avoid rainy periods
2. Schedule projects to disturb only small portions of the site at any one time.
3. Complete grading as soon as possible.
4. Immediately stabilize the disturbed portion before grading the next portion.
5. Practice staged seeding in order to re-vegetate cut and fill slopes as the work progresses.

BMP CN- 102

WHEEL WASH

DESCRIPTION

When a stabilized construction entrance is not preventing sediment from being tracked onto pavement, a wheel wash may be installed. Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right of way where the water from the dripping vehicle can run unimpeded into the street. Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10- foot x 10- foot sump can be effective.

ADVANTAGES

1. Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

DESIGN CRITERIA

1. Construction details are to be approved prior to construction by either the Madison County Drainage Board / their designated representative or the Madison County Engineer.
2. A minimum of six (6) inches of asphalt treated base (ATB) over crushed base material or eight (8) inches of asphalt over a stable subgrade is recommended to cover the wheel wash.
3. Use a low clearance truck or low-boy trailer to test the wheel wash for clearance prior to paving.
4. Keep the water level in the wash to between twelve (12) and fifteen (15) inches to avoid damage to wheel hubs.
5. Midpoint spray nozzles are needed in extremely muddy conditions.
6. Wheel wash systems should be designed with a small grade change,

six (6) to twelve (12) inches for a ten (10) foot wide pond, to allow sediment to flow to the low side of the pond to help prevent re-suspension of sediment.

7. A drainpipe with a two (2) to three (3) foot riser pipe should be installed on the low side of the pond to allow for easy cleaning and refilling.
8. Polymers may be used to promote coagulation and flocculation in a closed loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 to 0.50 pounds per 1000 gallons of water increases effectiveness and reduces cleanup time.
9. If PAM is already being used for dust or erosion control and is being applied by a water truck, then the same truck may be used to change the wash water.
10. The wheel wash should start out the day with clean fresh water. The wash water should be changed a minimum of once daily.
11. On large earthwork projects where more than ten (10) trucks per hour are expected, the wash water should be changed more often.
12. Wheel wash or tire bath wastewater shall be discharged to a separate on - site treatment system, such as closed loop re-circulation or land application, or to the sanitary sewer with proper local sewer utility approval.

BMP CN - 103

DEWATERING STRUCTURE

DESCRIPTION

Water which is pumped from a construction site usually contains a large amount of sediment. A dewatering structure is designed to remove the sediment before water is released off-site.

This practice includes several types of dewatering structures which have different applications dependent upon site conditions and types of operation. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the Madison County Drainage Board, their designated representative or the Madison County Engineer.

DESIGN CRITERIA

1. A dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device without overtopping the structure.
2. Material from any required excavation shall be stored in an area and protected in a manner that will prevent sediments from eroding and moving off-site.
3. An excavated basin (applicable to "Straw Bale/Silt Fence Pit";may be lined with filter fabric to help reduce scour and to prevent the inclusion of soil from with in the structure.
4. A dewatering structure may not be needed if there is a well-stabilized, vegetated area onsite to which water may be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water with out eroding .A minimum filtering length of 75 feet must be available in order for such a method to be feasible.

6. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed.
7. The accumulated sediment which is removed from a dewatering device must be spread on-site and stabilized or disposed of at an approved disposal site as per approved plan.

Portable Sediment Tank:

a. The structure may be constructed with steel drums, HDPE, concrete or other material suitable for handling the pressure exerted by the volume of water.
b. Sediment tanks will have a minimum depth of 2 feet.
c. The sediment tank shall be located for easy clean-out and disposal of the trapped sediment and to minimize the interference with construction activities.
d. The following formula shall be used to determine the storage volume of the sediment tank. Pump discharge (gallons/min.) x 16 = cubic feet of storage required .
e. Once the water level nears the top of the tank, the pump must be shut off while the tank drains and additional capacity is made available..
f. The tank shall be designed to allow for emergency flow over the top of the tank. Clean-out of the tank is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

Filter Box:

a. The filter box selected should be made of steel, HDPE, concrete or other materials suitable to handle the pressure requirements imposed by the volume of water. Normally readily available 55 gallon drums welded top to bottom will suffice in most cases.
b. Bottom of the box shall be made porous by drilling holes (or pre-manufactured openings).

c. Coarse aggregate shall be placed over the holes at a minimum depth of 12 inches, metal hardware cloth may need to be placed between the aggregate and the holes if holes are drilled larger than the majority of the stone.

d. As a result of the fast rate of flow of sediment-laden water through the aggregate, the effluent must be directed over a well-vegetated strip of at least 50 feet after leaving the base of the filter box.

e. The box shall be sized as follows:
Pump discharge (gallon/min.) x 16 = cubic feet of storage required.

f. Once the water level nears the top of the box, the pump must be shut off while the box drains and additional capacity is made available.

g. The box shall be designed/constructed to allow for emergency flow over the top of the box.

h. Clean-out of the box is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

I. If the stone filter does become clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the inlet, cleaned and replaced.

j Using a filter box only allows for minimal settling time for sediment particles; therefore, it should only be used when site conditions restrict the use of other methods.

Straw Bale/Silt Fence Pit:

a. This measure shall consist of straw bales, silt fence, a stone outlet (a combination of riprap and aggregate) and a wet storage pit.

b. The structure must have a capacity which is dictated by the following formula: Pump discharge (gallons/min.) x 16 = cubic feet of storage required.

c. In calculating the capacity, one should include the volume available from the floor of the excavation to the crest of the stone weir. In any case, the excavated area should be a minimum of three (3) feet below the base of the perimeter measures (straw bales or silt fence).

d. The perimeter measures must be installed as per the guidelines found in BMP-4, STRAW BALE BARRIER and BMP-5, SILT FENCE.

e. Once the water level nears the crest of the stone weir (emergency overflow), the pump must be shut off while the structure drains down to the elevation of the wet storage.

f. The wet storage pit may be dewatered only after a minimum of six (6) hours of sediment settling time. This effluent should be pumped across a well vegetated area or through a silt fence prior to entering a watercourse.

g. Once the wet storage area becomes filled to one-half of the excavated depth, the accumulated sediment shall be removed and properly disposed of.

h. Once the device has been removed, ground contours will be returned to original condition.

REFERENCE

United States Army Corps of Engineers, Handbook for the Preparation of Storm Water Pollution Prevention for Construction Activities, 1997 or later.

BMP CN-104

SPILL PREVENTION AND CONTROL

DESCRIPTION

These procedures and practices are implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to the drainage system or watercourses.

This best management practice (BMP) applies to all construction projects. Spill control procedures are implemented any time chemical sand/or hazardous substances are stored.

Substances may include, but are not limited to:

1. Soil stabilizers/binders
2. Dust Palliatives
3. Herbicides
4. Growth inhibitors
5. Fertilizers
6. Deicing/anti-icing chemicals
7. Fuels
8. Lubricants
9. Other petroleum distillates

To the extent that the work can be accomplished safety, spills of oil, petroleum products, sanitary and septic wastes, and substances listed under 40 CFR parts 110, 117 and 302 shall be contained and cleaned up immediately.

LIMITATIONS

1. This BMP only applies to spills caused by the contractor.

2. Procedures and practices presented in this BMP are general. The

contractor shall identify appropriate practices for the specific materials used or stored on-site in advance of their arrival at the site.

DESIGN CRITERIA

1. To the extent that it doesn't compromise cleanup activities, spills shall be covered and protected from storm water runoff during rainfall.
2. Spills shall not be buried or washed with water.
3. Used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose shall be stored and disposed of in conformance with BMP CN-106: Hazardous waste Management.
4. Water used for cleaning and decontamination shall not be allowed to enter storm drains or water courses and shall be collected and disposed of in accordance with BMP CN-106: Hazardous Waste Management.
5. Water overflow or minor water spillage shall be contained and shall not be allowed to discharge into drainage facilities or water courses.
6. Proper storage, clean-up and spill reporting instruction for hazardous materials stored or used on the project site shall be posted at all times in an open, conspicuous and accessible location.
7. Waste storage areas shall be kept clean, well organized and equipped with ample clean-up supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers and liners shall be repaired or replaced as needed to maintain proper function.
8. Verify weekly that spill control and cleanup materials are located near material storage, unloading and use areas.
9. Update spill prevention and control plans and stock appropriate clean-up materials whenever changes occur in the types of chemicals used or stored onsite.

   Cleanup and Storage Procedures for Minor Spills:

   a. Minor spills typically involve small quantities of oil, gasoline, paint, etc.,which can be controlled by the first responder at the discovery of the spill.

b. Use absorbent materials on small spills rather than hosing down or burying the spill.

c. Remove the absorbent materials promptly and dispose of properly.

d. The practice commonly followed for a minor spill is:

   1 Contain the spread of the spill.

   2 Recover spilled materials.

   3 Clean the contaminated area and /or properly dispose of contaminated materials.

Cleanup and Storage Procedures for Semi-Significant Spills:

a. Semi-significant spills can still be controlled by the first responder along with the aid of other personnel. This response may require the cessation of all other activities.

b. Clean up spills immediately.

c. Notify the project foreman immediately. The foreman shall notify the Madison County Emergency Management Agency's Hazardous Materials Response Team.

d. Contain the spread of the spill. .

e. If the spill occurs on paved or impermeable surfaces, cleanup using dry methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.

f. If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.

g. If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Cleanup and Storage Procedures for Significant / Hazardous Spills:

a. For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.

b. For spills of "Federal Reportable Quantities", in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor shall notify the National Response Center at (800) 424-8802.

c. Notification shall first be made by telephone and followed up with a written report.

d. The services of a spills contractor or a Haz-Mat Team shall be obtained immediately. Construction personnel shall not attempt to clean up the spill until the appropriate and qualified personnel have arrived at the job site.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later.

BMP CN-105

SOLID WASTE MANAGEMENT

DESCRIPTION

Solid waste management procedures and practices are designed to minimize or eliminate the discharge of pollutants to the drainage system or to watercourses as a result of the creation, stockpiling, or removal of construction site wastes.

Solid waste management procedures and practices are implemented on all construction projects that generate solid wastes.

Solid wastes include but are not limited to:

1. Construction wastes including brick, mortar, timber, steel and metal scraps, sawdust, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials.
2. Landscaping wastes, including vegetative material, plant containers, and packaging materials.
3. Litter, including food containers, beverage cans, coffee cups, paper and plastic bags, plastic wrappers, and smoking materials, including litter generated by the public.

LIMITATIONS

1. Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season.

DESIGN CRITERIA

1. Dumpsters of sufficient size and number shall be provided to contain the solid waste generated by the project and properly serviced.
2. Littering on the project site shall be prohibited.
3. To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines shall be a priority.
4. Trash receptacles with lids shall be provided in the Contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
5. Construction debris and litter from work areas within the construction limits of the project site shall be collected and placed in water tight dumpsters at least weekly regardless of whether the litter was generated by the Contractor, the public, or others. Collected litter and debris shall not be placed in or next to drain inlets, storm water drainage systems or water courses.
6. Full dumpsters shall be removed from the project site and the contents shall be disposed of, off-site, in an appropriate manner.;
7. Litter stored in collection areas and containers shall be handled and disposed of by trash hauling contractors.
8. Construction debris and waste shall be removed from the site every two weeks.
9. Storm water run-off shall be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
10. Solid waste storage areas shall be located at least 50 feet from drainage facilities and water courses and shall not be located in areas prone to flooding or ponding.
11. Except during fair weather, construction and landscaping waste not stored in water tight dumpsters shall be securely covered from wind and rain by covering the waste with tarps, plastic sheeting, or equivalent.

12. Dumpster washout on the project site is not allowed.
13. Notify trash hauling contractors that only water tight dumpsters are acceptable for use on-site.
14. Plan for additional containers during the demolition phase of construction.
15. Plan for more frequent pickup during the demolition phase of construction.
16. Construction waste shall be stored in a designated area. Access to the designated area shall either be well vegetated ground, a concrete or asphalt road or drive, or a gravel or stone construction entrance, to avoid mud tracking by trash hauling contractors.
17. Segregate potentially hazardous waste from non-hazardous construction site waste.
18. Keep the site clean of litter debris.
19. Make sure that toxic liquid wastes (e.g.,used oils, solvents, and paints) and chemicals (e.g. acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
20. For disposal of hazardous waste, see BMP CN-106: Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
21. Salvage or recycle useful vegetation debris, packaging and/or surplus building materials when practical. For example, trees and shrubs from land clearing can be converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.
22. Prohibit littering by employees, subcontractors and visitors.
23. Wherever possible, minimize production of solid waste materials.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later.

BMP CN-106

HAZARDOUS WASTE MANAGEMENT

DESCRIPTION

These are procedures and practices to minimize or eliminate the discharge of pollutants from construction site hazardous waste to the storm drain systems or to watercourses.

This best management practice (BMP) applies to all construction projects.

Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

1. Petroleum Products
2. Asphalt Products
3. Concrete Curing Compounds
4. Pesticides
5. Acids
6. Paints
7. Stains
8. Solvents,
9. Wood Preservatives
10. Roofing Tar
11. Any materials deemed a hazardous waste in 40 CFR Parts 110, 117, 261 or 302.

DESIGN CRITERIA

Storage Procedures:

1. Wastes shall be stored in sealed containers constructed of a suitable material and shall be labeled as required by 49 CFR parts 172, 173, 178 and 179.

required in 49 CFR 261-263.

3. Waste containers shall be stored in temporary containment facilities that shall comply with the following requirements:
   a. temporary containment facility shall provide for a spill containment volume able to contain precipitation from a 24-hour, 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, which ever is greater.
   b. Temporary containment facility shall be impervious to the materials stored there for a minimum contact time of 72 hours.
   c. Temporary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks accumulated rain water and spills shall be placed into drums after each rainfall. These liquids shall be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids shall be sent to an approved disposal site.
   d. Sufficient separation shall be provided between stored containers to allow for spill cleanup and emergency response access. Incompatible materials such as chlorine and ammonia, shall not be stored in the same temporary containment facility.
   e. Through out the rainy season, temporary containment facilities shall be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs. A storage facility having a solid cover and sides is preferred to a temporary tarp. Storage facilities shall be equipped with adequate ventilation.
4. Drums shall not be overfilled and wastes shall not be mixed.
5. Unless water tight, containers of dry waste shall be stored on pallets.
6. Paint brushes and equipment for water and oil based paints shall be cleaned within a contained area and shall not be allowed to contaminate site soils, watercourses or drainage systems. Waste paints,

thinners, solvents, residues, and sludge that can not be recycled or reused shall be disposed of as hazardous waste.
When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths shall be disposed of as solid waste.

7. Ensure that adequate hazardous waste storage volume is available.
8. Ensure that hazardous waste collection containers are conveniently located.
9. Designate hazardous waste storage areas on site away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
10. Minimize production or generation of hazardous materials and hazardous waste on the job site.
11. Use containment berms in fueling and maintenance areas and where the potential for spills is high.
12. Segregate potentially hazardous waste from non-hazardous construction site debris.
13. Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.
14. Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
15. Place hazardous waste containers in secondary containment.
16. Do not allow potentially hazardous waste materials to accumulate on the ground.
17. Do not mix wastes.

Disposal Procedures:

1. Waste shall be removed from the site within 90 days of being generated.
2. Waste shall be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest Forms.

3. A certified laboratory shall sample waste and classify it to determine the appropriate disposal facility.
4. Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for solid waste construction debris.
5. Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
6. Recycle any useful material such as used oil or water-based paint when practical.

Maintenance and Inspection

1. A foreman and/or construction supervisor shall monitor on-site hazardous waste storage and disposal procedures.
2. Waste storage areas shall be kept clean, welt organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.
3. Storage areas shall be inspected in conformance with the provisions in the contract documents.
4. Perimeter controls, containment structures, covers, and liners shall be repaired or replaced as needed to maintain proper function.
5. Hazardous spills shall be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
6. The National Response Center, at (800) 424-8802, shall be notified of spills of Federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302.
7. Copy of the hazardous waste manifests shall be provided to the Owner.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later.

APPENDIX D

POST - CONSTRUCTION BMPs

BMP PC 101

BIORETENTION FACILITY

DESCRIPTION

Bioretention is a best management practice (BMP) developed in the early 1990's by the Prince George's County, Maryland, Department of Environmental Resources (PGDER). Bioretention utilizes soils and both woody and herbaceous plants to remove pollutants from storm water runoff. Runoff is conveyed as sheet flow to the treatment area, which consists of a grass buffer strip, sandbed, ponding area, organic layer or mulch layer, planting soil, and plants.
Runoff passes first over or through a sand bed which slows the runoff's velocity, distributes it evenly along the length of the ponding area, which consists of a surface organic layer and / or ground cover and the underlying planting soil. The ponding area is graded; its center depressed. Water is ponded to a depth of six (6) inches and gradually infiltrates the bioretention area and / or is evapotranspired. Bioretention areas are applicable as on-lot retention facilities that are designed to mimic forested systems that naturally control hydrology. The bioretention area is graded to drain excess runoff over a weir and into the storm drain system, Stored water in the bioretention area planting soil infiltrates over a period of days into the underlying soils.

The basic bioretention design shown below can be modified to accommodate more specific needs. The bioretention BMP design can be modified to include an under drain within the sand bed to collect the infiltrated water and discharge it to a downstream storm drain system. This modification may be required when impervious subsoils and marine clays prevent complete infiltration in the soil system. This modified design makes the bioretention area act more as a filter that discharges treated water than as an infiltration device.

COMPONENTS

1. Grass Buffer Strip: Designed to filter out particulates and reduce runoff velocity.
2. Sand Bed: Further reduces velocity by capturing a portion of the runoff

and distributes it evenly along the length of the ponding area. It also provides aeration to the plant bed and enhances infiltration.

3. Ponding Area: Collects and stores runoff prior to infiltration.
4. Organic / Mulch Layer: Provides some filtering of runoff, encourages development of beneficial microorganisms, and protects the soil surface from erosion.
5 Planting Soil: Provides nourishment for the plant life. Clay particles within the soil also remove certain pollutants through adsorption.
6. Plants: Provides uptake of harmful pollutants.

ADVANTAGES

1. If designed properly, has shown ability to remove significant amounts of dissolved heavy metals, phosphorous, TSS, and fine sediments.
2. Requires relatively little engineering design in comparison to other stormwater management facilities (e.g. sand filters).
3. Provides groundwater recharge when the runoff is allowed to infiltrate into the subsurface.
4. Enhances the appearance of parking lots and provides shade and wind breaks, absorbs noise, and improves an area's landscape.
5. Maintenance on a bioretention facility is limited to the removal of leaves from the bioretention area each fall.
6. The vegetation recommended for use in bioretention facilities is generally hardier than the species typically used in parking lot landscapes. This is a particular advantage in urban areas where plants often fare poorly due to poor soils and air pollution.

LIMITATIONS

1. Low removal of nitrates.
2. Not applicable on steep, unstable slopes or landslide areas (slopes greater than 20 percent).
3. Requires relatively large areas.

4. Not appropriate at locations where the water table is within six (6) feet of the ground surface and where the surrounding soil stratum is unstable.
5. Clogging may be a problem, particularly if the BMP receives runoff with high sediment loads.

DESIGN CRITERIA

1. Calculate the volume of stormwater to be mitigated by the bioretention facility using the water quality volume calculations outlined in Chapter 8.
2. The soil should have infiltration rates greater than 0.5 inches per hour, otherwise an underdrain system should be included (see# 11 below).
3. Drainage to the bioretention facility must be graded to create sheet flow, not a concentrated stream. Level spreaders (i.e. slotted curbs) can be used to facilitate sheet flow. The maximum sheet flow velocity should be 1 ft. per sec. for the planted ground cover and 3 ft. per sec. for mulched cover.
4. Soil shall be a uniform mix, free of stones, stumps, roots or other similar objects larger than 1 inch in diameter. No other materials or substances shall be mixed or dumped within the bioretention area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations. The planting soil shall be free of noxious weeds.
5. Planting soil shall be tested and meet the following criteria:

Planting Soil Criteria

pH range	52 - 70
Organic matter	1.5 to 4%
Magnesium	35 lbs. per acre, minimum
Phosphorus P(2), O(5)	75 lbs. per acre, minimum
Potassium K(2) O	85 lbs. per acre, minimum
Soluble salts	not to exceed 500 ppm
Clay	0 - 25% by volume
Silt	30 - 55% by volume
Sand	35 - 60% by volume

6. It is very important to minimize compaction of both the base of the bioretention area and the required backfill. When possible, use backhoe excavators to remove the original soil. If excavated using a loader, the excavator should be equipped with a wide track or marsh track or if not on tracks, light equipment with turf type tires. Use of equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high pressure tires will cause excessive compaction resulting in reduced infiltration rates and storage volumes and is not acceptable. Compaction will significantly contribute to design failure.
7. Compaction can be alleviated at the base of the bioretention facility by using a primary tilling operation such as a chisel plow ripper, or subsoiler. These tilling operations are to re-fracture the soil profile through the 12 inch compaction zone. Substitute methods must be have prior approval from the Drainage Board, their designated representative or the County Engineer. Rototillers typically do not till deep enough to reduce the effects of compaction from heavy equipment. Rototill 2 to 3 inches of sand into the base of the bioretention facility before back filing the required sand layer. Pump any ponded water before preparing (rototilling) the base.
8. When back filling top soil over the sand layer, first place 3 to 4 inches of topsoil over the sand, then rototill the sand / topsoil to create a gradation zone. Backfill the remainder of the topsoil to final grade.
9. Mulch around individual plants only. Shredded hardwood mulch is the only accepted mulch. Shredded hardwood mulch must be well aged (stockpiled or stored for at least 12 months) for acceptance. The mulch should be applied to a maximum depth of three (3) inches.
10. The plant root ball should be planted so l/8th of the ball is above final grade surface.
11. If used, place perforated pipe underdrains on a 3 feet wide section of filter cloth followed by a gravel bedding. The pipe is placed next, followed by another three (3) feet wide section of filter cloth. Next the fabric covered pipe is gravel backfilled. The ends of underdrain pipes not terminating in an observation well shall be capped.
12. The main collector pipe for underdrain systems shall be constructed at a minimum slope of at least 0.5% unless prior approval from the

Board, their designated representative or County Engineer has been obtained. Observation wells and / or clean-out pipes must be provided (one minimum per every 1,000 square feet of surface area)

13. Size an emergency overflow weir with six (6) inches of head, using the Weir equation:

$$Q = CL\,H\,(3/2)$$

Where:

Q = flow rate
H = 0.5 foot of head
L = length of weir
C = 2.65 (smooth crested grass weir)

14. Bioretention areas should be at least 15 feet wide with a 25 foot width preferable, and a minimum length of 40 feet. Generally, the length-to-width ratio should be around 2 : 1 to improve surface flow characteristics.
15. The plant soil depth should be four (4) feet or more to provide beneficial root zone, both in terms of space and moisture content.
16. The depth of the ponding area should be limited to no more than six (6) inches to limit the duration of standing water to no more than four (4) days. If an underdrain system is used, the depth of the ponding area should be limited to no more than one (1) foot. Longer ponding times can lead to anaerobic conditions that are not conductive to plant growth. Longer periods of standing water can also lead to the breeding of mosquitoes and other pests.
17. The bioretention area should be vegetated to resemble a terrestrial forest community ecosystem, which is dominated by understory trees, a shrub layer, and herbaceous ground covers. Three species each of both trees and shrubs are recommended to be planted at a rate of 1000 total trees and shrubs per acre. The shrub-to-tree ratio should be from 2 : 1 to 3 : Trees should be spaced 12 feet apart and the shrubs should be spaced 8 feet apart.

BMP PC 102

CATCH BASIN INSERTS

DESCRIPTION

A catch basin insert is any device that can be inserted into an existing catch basin designed to provide some level of runoff contaminant removal. Currently, there are many different catch basin insert models available, with applications ranging from trash and debris removal to carbon adsorption of aliphatic and aromatic hydrocarbons and heavy metals removal. Costs vary widely. The most frequent application for catch basin inserts is for reduction of sediment, oil, and grease levels in stormwater runoff. These catch basin inserts should also have an overflow outlet, through which water exceeding the treatment capacity can escape without flooding the adjacent area.

ADVANTAGES

1 Provides moderate removal of larger particles and debris as pretreatment.
2 Low installation costs.
3. Units can be installed in existing traditional stormwater infrastructure.
4. Ease of installation.
5. Requires no additional land area.

LIMITATIONS

1. Vulnerable to accumulated sediments being re-suspended at low flow rates.
2. Severe clogging potential if exposed soil surfaces exist upstream.
3. Maintenance and inspection of catch basin inserts are to be required before and after each future rainfall event, requiring excessive cleaning and maintenance.
4. Available hydraulic head to meet design criteria.

5. Dissolved pollutants are not captured by filter media.
6. Limited pollutant removal capabilities.

DESIGN CRITERIA

1. Calculate the flow rate of stormwater to be mitigated by the catch basin insert using the methodology outlined in Chapter 8.
2. Insert device selected should be Best Available Technology for removing constituents of concern for the particular site.

Because of the susceptibility for clogging and extensive maintenance, the developer should pay special attention to addressing the maintenance and inspection provisions for catch basin inserts after each storm event (greater than 0.5" of rainfall) over the life of the development, including financial provisions for this activity. This factor often discourages the use of catch basin inserts.

BMP PC - 103

CISTERN

DESCRIPTION

Cisterns are containers which capture stormwater runoff as it flows from the roofs to the gutters and comes down through the gutter downspouts. The cisterns are also known as "rain barrels". Collected stormwater can later be used to water the garden or lawn. The collection of this stormwater reduces the amount of stormwater runoff and assists in the reduction of potential pollutants entering the storm water conveyance system. In a residential application, rain barrels are incorporated into the plan for each lot. In order to be effective, there must be some provision for ensuring that the cisterns will be maintained.

ADVANTAGES

1. Low installation cost.
2. Requires little space for installation.
3. Reduces amount of stormwater runoff.
4. Conserves water usage.

LIMITATIONS

1. Limited amount of storm water runoff can be captured.
2. Restricted to structure runoff.
3. Aesthetically unpleasing.

DESIGN CRITERIA

1. Calculate the volume of stormwater to be mitigated by the cistern using the methods outlined in Chapter 8.

BMP PC - 104

CONSTRUCTED WETLANDS

DESCRIPTION

Wetlands provide physical, chemical, and biological water quality treatment of stormwater runoff. Physical treatment occurs as a result of decreasing flow velocities in the wetland, and is present in the form of evaporation, sedimentation, adsorption, and / or filtration. Chemical processes include chelation, precipitation, and chemical adsorption. Biological processes include decomposition, plant uptake and removal of nutrients, plus biological transformation and degradation. Hydrology is one of the most influential factors in pollutant removal due to its effects on sedimentation, aeration biological transformation, and adsorption onto bottom sediments. The large surface area of the bottom of the wetland encourages higher levels of adsorption, filtration, microbial transformation. and biological utilization than might normally occur in more channelized watercourses.

A natural wetland is defined by examination of the soils, hydrology, and vegetation which are dominant in the area. Wetlands are characterized by the substrate being predominantly undrained hydric soil. A wetland may also be characterized by a substrate which is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. Wetlands also usually support hydrophytes, or plants which are adapted to aquatic and semi-aquatic environments. Natural and artificial wetlands are used to treat stormwater runoff. Figure l0-2 illustrates an artificial wetland used for treating stormwater runoff.

The success of a wetland will be much more likely if some general guidelines are followed. The wetlands should be designed such that a minimum amount of maintenance is required. This will be affected by the plants, animals, microbes, and hydrology. The natural surroundings, including such things as the potential energy of a stream or a flooding river, should be utilized as much as possible. lt is necessary to recognize that a fully functional wetland cannot be established spontaneously. Time is required for vegetation to establish and for nutrient retention and wildlife enhancement to function efficiently. Also, the wetland should approximate a natural situation as much as possible, and unnatural attributes, such as a rectangular shape or a rigid channel, should be avoided.

1. Natural Wetland Systems:
   Existing wetlands perform storm water treatment in the same fashion as constructed wetlands. However, current policy of the Indiana Department of Environmental Management may prohibit the use of existing wetlands as a pollution control measure. Therefore, the use of existing wetlands as a proposed BMP cannot be accepted by the Madison County Drainage Board and or Madison County Engineer without the prior written acceptance by IDEM for such proposed pollution control use.

2. Constructed (Artificial) Wetland Systems:
   Site considerations should include the water table depth, soil / substrate, and space requirements. Because the wetland must have a source of flow, it is desirable that the water table is at or near the surface. This is not always possible. If runoff is the only source of inflow for the wetland, the water level often fluctuates and the establishment of vegetation may be difficult. The soil or substrate of an artificial wetland should be loose loam to clay. A perennial base flow must be present to sustain the artificial wetland. The presence of organic material is often helpful in increasing pollutant removal and retention.
   Wetland vegetation can be categorized as either emergent, floating, or submerged. Emergent vegetation is rooted in the sediments, but grows through the water and above the water surface. Floating vegetation is not rooted in the sediments, and has aquatic roots with plant parts partly submerged or fully exposed on the water or surface. Submerged vegetation includes aquatic plants such as algae or plants rooted in the sediments, with all plant parts growing within the water column. Pollutant removal rates generally improve with an increase in the diversity of the vegetation.

The depth of inundation will contribute to the pollutant removal efficiency. Generally, shallow water depths allow for higher pollutant removal efficiencies due to an increased amount of adsorption onto bottom sediments. Flow patterns in the wetland will affect the removal efficiency also. Meandering channels, slow-moving water and a large surface area will increase pollutant removal through increased sedimentation. Shallow sheet flow also increases the pollutant removal capabilities through assimilative processes. A deep pool sometimes improves the denitrification potential. A mixed flow pattern will increase overall pollutant removal efficiency.
Using a site where nearby wetlands still exist is recommended if possible. A hydrologic study should be done to determine if flooding occurs and saturated soils are present. A site where natural inundation is frequent is a good potential site. Loamy soils are required to permit plants to take root.

ADVANTAGES

1. Constructed wetlands offer natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal.
2. Constructed wetlands can offer good treatment following treatment by other BMPs, such as wet ponds, that rely upon settling of larger sediment particles. They are useful for large basins when used in conjunction with other BMPs.
3. Wetlands which are permanently flooded are less sensitive to polluted water inflows because the ecosystem does not depend upon the polluted water inflow.
4. Can provide uptake of soluble pollutants such as phosphorous, through plant uptake.
5. Can be used as a regional facility

LIMITATIONS

1. Although the use of natural wetlands may appear to be more cost effective than the use of constructed wetlands, environmental permitting and legal issues may prohibit the use of natural wetlands for this purpose.
2. Wetlands require a continuous base flow.
3. If not properly maintained, wetlands can accumulate salts and scum which can be flushed out by large storm flows.
4. Regular maintenance, including plant harvesting is required to provide nutrient removal.
5. Frequent sediment removal is required to maintain the proper functioning of the wetland.
6. A greater amount of space is required for a wetland system than is required for an extended dry detention basin treating the same amount of area.
7. Although constructed wetlands are designed to act as nutrient sinks, on occasion, the wetland may periodically become a nutrient source.
8. Wetlands which are not permanently flooded are more likely to be affected by drastic changes in inflow of polluted water.
9. Cannot be used on steep unstable slopes or densely populated areas.
10. Harvested wetlands may require special disposal methods, due to heavy metal uptake.
11. Threat of mosquitoes.
12. Hydraulic capacity may be reduced with plant overgrowth.

DESIGN CRITERIA

The wetland may be designed as either a stand-alone BMP, or as part of a larger non-point source treatment facility in conjunction with other devices, such as a wet pond, sediment forebay, or infiltration basin. Basic design elements and considerations are listed below.

1. Volume:
   The wetland pond should provide a minimum permanent storage

equal to three-fourths of the water quality volume. The full water quality capture volume should be provided above the permanent pool. Calculate the water quality volume to be mitigated by the wetland using the method of Chapter 8.

2. Depth.

A constant shallow depth should be maintained in the wetland at approximately one (1) foot or less with 0.5 from being more desirable. If the wetland is designed as a very shallow detention pond the pond should provide the full water quality capture volume above the permanent pool level. The permanent wetland depth should be 6 to 12 inches deep. The depth of the water quality volume above the permanent pool should not exceed two (2) feet. Regrading may be necessary to allow for this shallow depth over a large area.

It may also be beneficial to create a wetland with a varying depth. A varying depth within the wetland will enable more diverse vegetation to flourish. Deep water offers a habitat for fish, creates a low velocity area where flow can be redistributed, and can enhance nitrification as a prelude to later denitrification if nitrogen removal is desired. Open water areas may vary in depth between two (2) and four (4) feet.

3 Surface Area

Increasing the surface area of the pond increases the nutrient removal capability. A general guideline for surface area is using a marsh area of two to three percent of the contributing drainage area. The minimum surface area of the pond can also be calculated by determining the nutrient loading to the wetland. The nutrient loading to a wetland used for stormwater treatment should not be more than 45 lbs/acre of phosphorus or 225 lbs/acre of nitrogen per year. The pond could be sized to meet this minimum size requirement if the annual nutrient load at the site is known. If unknown, the nutrient loads can be estimated using the methodology of Chapter 7.

4. Longitudinal Slope.

Both wetland ponds and channels require a near-zero longitudinal slope.

5. Base Flow

Enough inflow must be present in the wetland to maintain wetland soil and vegetation conditions. A water balance should be calculated. Dependence on ground water for a moisture supply is not recommended.

Net change in storage is calculated as follows:

$$S = Qi + R + Inf - Qo - ET$$

Where:

S = net change in storage
Qi = stormwater runoff inflow
R = contribution from rainfall
Inf = net infiltration (infiltration - exfiltration
Qo = surface outflow
ET = evapotranspiration

6. Seeding:

It is important that any seed which is used to establish vegetation germinate and take root before the site is inundated, or the seeds will be washed away. Live plants (plugs) should be considered for areas inundated, even during construction.

7. Length to Width Ratio:

The pond should gradually expand from the inlet and gradually contract toward the outlet. The length to width ratio of the wetland should be 2..1 to 4:1, with a length to width ratio of 3:l recommended.

8. Emptying Time:

The water quality volume above the permanent pool should empty in approximately 24 hours. This emptying time is not for the wetland itself, but for the additional storage above the wetland. Failure to approach this criteria is often the source of failure for constructed wetlands planned for the base of a water quantity storage facility.

9. Inlet und Outlet Protection. Inlet and outlet protection should be

provided to reduce erosion of the basin. Velocity should be reduced at the entrance to reduce resuspension of sediment by using a forebay The forebay should be approximately five (5) to ten (10) percent of the water quality capture volume. The outlet should be placed in an offbay at least three (3) feet deep. It may be necessary to protect the outlet with a skimmer shield that starts approximately one-half of the depth below the permanent water surface and extends above the maximum capture volume depth. A skimmer can be constructed from a stiff steel screen material that has smaller openings than the outlet orifice or perforations.

10. Infiltration Avoidance:
    Loss of water through infiltration should be avoided. This can be done by compacting the soil, incorporating clay into the soil, or lining the pond with a artificial lining.
11. Side Slopes:
    Side slopes should be gradual to reduce erosion and enable easy maintenance. Side slopes should not be steeper than 4:1, and 5:1 is preferable.
12. Open Water:
    At least 25 percent of the basin should be an open water area at least two (2) feet deep if the device is exclusively designed as a shallow marsh. The open water area will make the marsh area more aesthetically pleasing and the combined water/wetland area will create a good habitat for waterfowl. The combination of forebay, outlet and free water surface should be 30 to 50 percent and this area should be between two (2) and four (4) feet deep. The wetland zone should be 50 to 7o percent of the area and should be six (6) to twelve (12) inches deep.
13. Freeboard:
    The wetland pond should be designed with at least one (1) foot of freeboard.
14. Use With Wet Pond:
    Shallow marshes can be established at the perimeter of a wet pond by grading to form a 10 foot to 20 foot wide shallow bench. Aquatic emergent vegetation can be established in this area. A shallow marsh area can also be used near the inflow channel for sediment deposition.

15. Shape:
The shape is an important aspect of the wetland. It is recommended that a littoral shelf with gently sloping sides of 6:1 or flatter be constructed to a point 24 to 28 inches below the water surface. Bottom slopes of less than one percent are also recommended.
16. Soils:
Clay soils underlying the wetland will help prevent percolation of water to groundwater. However, clay soils will also prevent root penetration, inhibiting growth. Loam and sandy soils may then be preferable. A good design may be the use of local soils at the upper layer with clay beneath to prevent infiltration.
17. Vegetation:
Vegetation must be established in the wetland to aid in slowing down velocities and nutrient uptake in the wetland. A dependable way of establishing vegetation in the wetland is to transplant live plants or dormant rhizomes from a nursery. Emergent plants may eventually migrate into the wetland from upstream, but this is not a reliable source of vegetation. Transplanting vegetation from existing wetland areas is not encouraged, as it may damage the existing wetland area. Seeding is more cost effective, but is also not reliable Vegetation should be selected by a qualified wetland scientist.
18. Forebay:
A forebay may be provided to partially protect proposed wetland plantings from sediment loadings. If a forebay is provided the forebay volume should be about five (5) to ten (10) percent of the water quality volume.

BMP PC - 105

EXTENDED/DRY DETENTION BASIN OR UNDERGROUND DETENTION SYSTEMS

DESCRIPTION

Extended/dry detention basins are depressed basins that temporarily store a portion of stormwater runoff following a storm event. Underground detention systems consisting of tanks, concrete vaults, pipes or some other storage facility function similar to detention basins. However, since underground detention systems are located below ground, the surface above these systems can be utilized for other more useful needs i.e. parking lots, sidewalks, landscaping adjacent to buildings, etc. Water is controlled by means of a hydraulic control structure (reduced pipe sizing, orifice and/or weirs) to restrict outlet discharge. The extended/dry detention basins and underground detention systems normally do not have a permanent water pool between storm events. The objectives of all systems are to remove particulate pollutants and to reduce maximum runoff values associated with development to their pre-development levels. Detention basin facilities may be berm-encased areas or excavated basins. Underground detention facilities may consist of corrugated metal pipe, HDPE plastic pipe or pipe arch, concrete pipe, or concrete vaults and the voids provided by granular backfill materials.

ADVANTAGES

1. Modest removal efficiencies for the larger particulate fraction of pollutants.
2. Removal of sediment and buoyant materials. Nutrients, heavy metals, toxic materials, and oxygen-demanding particles are also removed with sediment substances associated with the particles.
3. Can be designed for combined flood control and storm water quality control.

4. May require less capital cost and land area when compared to wet pond BMP.
5. Downstream channel protection when properly designed and maintained.

LIMITATIONS

1. Requires sufficient area and hydraulic head to function properly.
2. Generally not effective in removing dissolved and finer particulate size pollutants from stormwater.
3. Some constraints other than the existing topography include, but are not limited to, the location of existing and proposed utilities, depth to bedrock, location and number of existing trees, and wetlands.
4. Extended/dry detention basins have moderate to high maintenance requirements.
5. Sediments can be re-suspended if allowed to accumulate over time and escape through the hydraulic control outlet to downstream channels and streams.
6. Some environmental concerns with using extended/dry detention basins include potential impact on wetlands, wildlife habitat, aquatic biota, and downstream water quality.
7. May create mosquito breeding conditions and other nuisances.

DESIGN CRITERIA

EXTENDED/DRY DETENTION BASINS:

	Criteria:	Consideration
1.	Storage Volume	Calculate the volume of stormwater to be mitigated by the extended / dry detention basin using the method in Chapter 8. Provide a storage volume for 120 percent of the

		water quality volume. The additional 20 percent of storage volume provides for sediment accumulation and the resultant loss in storage volume.
2.	Emptying time	A 24 to 48 hour emptying time should be used for the runoff volume, generated from water quality volume, with no more than 50 percent of the water quality volume being released in 12 hours.
3.	Basin geometry	Shape the pond with a gradual expansion from the inlet and a gradual contraction toward the outlet, thereby limiting short circuiting. The basin length to width ratio should be not less than 4 : 1.
4.	Two-stage design	A two-stage design with a lower frequency pool that fills often with frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin can enhance water quality benefits. The bottom stage should store 10 to 25 percent of the water quality volume.
5.	Low-flow channel	Conveys low base flows from the forebay to the outlet. Erosion protection should be provided for the low-flow channel.
6.	Basin side slopes	Slopes should be stable and gentle enough to limit rill erosion and facilitate maintenance access and needs. Side slopes should be no steeper than 4 : 1, preferably flatter.
7.	Inlet	Dissipate flow energy at basin's inflow point(s) to limit erosion and promote particle sedimentation.
8.	Forebay design	Provide the opportunity for larger particles to settle out in an area that has, as a useful refinement, a solid surface bottom to

		facilitate mechanical sediment removal. The forebay volume should be 5 to 10 percent of the water quality volume.
9.	Outlet design	Use a water quality outlet that is capable of slowly releasing the water quality over a 24 to 48 hour period. A perforated riser can be used in conjunction with orifices and a weir box opening above it to control larger storm outflows. An anti-seep collar should be considered for the outlet pipe to control seepage.
10.	Perforation protection	Provide a crushed rock blanket of sufficient size to prevent clogging of the primary water quality outlet while not interfering significantly with its hydraulic capacity.
11.	Dam embankment	The embankment should be designed not to fail during a 100-yr and larger storm. Embankment slopes should be no steeper than 3 : l, preferably 4 : 1, and flatter, and planted with turf-forming grasses. Poorly compacted native soils should be excavated and replaced. Embankment soils should be compacted to at least 95 percent of their maximum dry density (standard Proctor).
12.	Vegetation	Bottom vegetation provides erosion control and sediment entrapment. Basin bottom, berms, and side-sloping areas may be planted with native grasses or with irrigated turf, depending on the local setting.
13.	Maintenance access	Access to the forebay and outlet area shall be provided to maintenance vehicles. Maximum grades should be eight percent, and a solid driving surface of gravel, rock, concrete, gravel-stabilized turf, or other approved surface should be provided.

UNDERGROUND DETENTION SYSTEMS:

	Criteria	Consideration
1.	Storage volume	Calculate the volume of stormwater to be mitigated by the extended/dry detention basin using the method in Chapter 8. Provide a storage volume for 120 percent of the water quality volume. The additional 20 percent of storage volume provides for sediment accumulation and the resultant loss in storage volume.
2.	Emptying time	A 24 to 48 hour emptying time should be used for the runoff volume generated from water quality volume, with no more than 50 percent of the water quality volume being released in 12 hours.
3.	Detention geometry	The Detention Materials should be constructed to fit within the site layout.
4.	Low-flow outlet	Convey slow base flows from the detention to the outlet.
5.	Outlet design	Use a water quality outlet that is capable of slowly releasing the runoff volume generated from 0.75 inches of rainfall over a 24 to 48 hour period.
6.	Overflow design	Runoff volume generated from a storm greater than the water quality event (See Chapter 8) should be diverted via a flow splitter placed at the detention facility entrance or an overflow weir/orifice designed in conjunction with the outlet of the detention facility.
7.	Maintenance access	Access to the detention facility shall be provided for maintenance personnel.

BMP PC - 106

INFILTRATION BASINS

DESCRIPTION

An infiltration basin is a surface pond which captures first-flush stormwater and treats it by allowing it to percolate into the ground and through permeable soils. As the stormwater percolates into the ground physical, chemical, and biological processes occur which remove both sediments and soluble pollutants. Pollutants are trapped in the upper layers of the soil, and the water is then released to ground water. Infiltration basins are generally used for drainage areas between 5 and 50 acres. For drainage areas less than 5 acres, an infiltration trench or other BMP may be more appropriate. For drainage areas greater than 50 acres, maintenance of an infiltration basin would be burdensome, and an extended/dry detention basin or wet pond may be more appropriate. Infiltration basins are generally dry except immediately following storms, but a low-flow channel may be necessary if a constant base flow is present.

Infiltration basins create visible surface ponds that dissipate as water is infiltrated through the pond bottom; infiltration trenches hide surface drainage in underground void regions and the water is infiltrated below the trench materials (rock, gravel). Infiltration basins effectively remove soluble pollutants because processes such as adsorption and biological processes remove these soluble pollutants from stormwater. This kind of treatment is not always available in other kinds of BMPs.

Several types of infiltration basins exist. They can be either in-line or off-line, and may treat different volumes of water, such as the water quality volume or the 2-year or 10-year storm. A full infiltration basin is built to hold the entire water quality volume, and the only outlet from the pond is an emergency spillway. More commonly used is the combined infiltration/detention basin, where the outflow is controlled by a vertical riser. Excess flow volume spills over the drop inlet at the top of the riser, and very large storms will exit through the emergency spillway. Other types of basins include the side-by-side basin, and the off-line infiltration basin. The side by side basin consists of a basin with an elevated channel to carry base flows running along one of its sides. Storm flows also flow through the elevated channel, but overflow the channel and enter the basin when they become deep enough. An off-line infiltration basin is used to treat the first flush runoff, while higher flows remain in the main charmel.

ADVANTAGES

1. High removal capability for particulate pollutants and moderate removal for soluble pollutants.
2. Ground water recharge helps to maintain dry-weather flows in streams.
3. Can minimize increases in runoff volume.
4. When properly designed and maintained, it can replicate pre-development hydrology more closely than other BMP options.
5. Basins provide more habitat value than other infiltration systems.

LIMITATIONS

1. High failure rate due to clogging and high maintenance burden.
2. Low removal of dissolved pollutants in very coarse soils.
3. Not suitable on fill slopes or steep slopes.
4. Risk of groundwater contamination in very coarse soils, may require groundwater monitoring.
5. Should not be used if significant upstream sediment load exists.
6. Slope of contributing watershed needs to be less than 2 percent.
7. Not recommended for discharge to a sole source aquifer.
8. Cannot be located within 100 feet of un-capped active drinking water wells.
9. Metal and petroleum hydrocarbons could accumulate in soils to potentially toxic levels.
10. Relatively large land area requirement.
11. Only feasible where soil is permeable and there is sufficient depth to bedrock and water table.
12. Need to be located a minimum of 10 feet down gradient and 100 feet up gradient from building foundations because of potential seepage problems.
13. Infiltration facilities could fall under additional regulations of IDEM

or IDNR regarding potential waste disposal to groundwater.

DESIGN CRITERIA

Designing an infiltration basin is a process in which several factors are examined. The soil type and the drainage area are important factors in infiltration basin design. If either one of these two is inappropriate, the infiltration basin will not function properly. The steps in the design of an infiltration basin are listed below.

1. Drainage Area:
   Drainage areas between 5 and 50 acres are good candidates for infiltration basins. Infiltration trenches might be more appropriate for smaller drainage areas, while retention ponds are more appropriate for larger drainage areas.
2. Soils:
   The site must have the appropriate soil, or the basin will not function properly. It is important that the soil be able to accept water at a minimum infiltration rate. Soils with an infiltration rate of less than 0.3 inches per hour, are not suitable sites for infiltration basins. Soils with a high percentage of clay are also undesirable and should not be used if the percentage of clay is greater than 30 percent. Generally, areas with fine to moderately fine soils prevalent should not be considered as infiltration sites because these soils do not have a high infiltration rate Soils with greater than 40 percent combined silt/clay also should not be used. A series of soil cores should be taken to a depth of at least 5 feet below the proposed basin floor elevation to determine which kinds of soils are prevalent at the potential site.
3. Volume:
   Calculate the volume of stormwater to be mitigated by the infiltration basin using the Methods of Chapter 8.
4. Slope:
   The basin floor should be as flat as possible to ensure an even infiltration surface and should not have a slope greater than 5 percent. Also, side slopes should have a maximum slope of 3 : 1.

5. Vegetation:
Vegetation should be established as soon as possible. Water-tolerant reed canary grass or tall endophyte free fescue should be planted on the floor and side slopes of the basin Root penetration and thatch formation maintains and sometimes improves infiltration capacity of the basin floor. Also, the vegetation helps to trap the pollutants by growing through the accumulated sediment and preventing re-suspension. The vegetation also helps reduce pollution levels by taking up soluble nutrients for growth and converting them into less available pollutant forms.
6. Inlet:
Sediment forebays or riprap aprons should be installed to reduce flow velocities and trap sediments upon entrance to the basin. Flow should be evenly distributed over the basin floor by a riprap apron. The inlet pile or channel should enter the basin at floor level to prevent erosion.
7. Drainage Time:
The basin should completely drain within 24 hours to avoid the risk of it not being empty before the next storm. Overestimation of the future infiltration capacity can result in a standing water problem. Ponds with detention times of less than six horns are not effectively removing pollutants from the storm flows. The most common problem is setting the elevation and size of the low-flow orifice. If the orifice is too large, runoff events pass through the basin too quickly. If the low-flow orifice diameter is too narrow, there is a risk of creating an undesirable quasi-permanent pool.
8. Buffer Zone:
A 25 foot buffer should be placed between the edge of the basin floor and the nearest adjacent property line. The buffer should consist of water tolerant, native plant species that provide food and cover for wildlife. This buffer zone may also act as a screen if necessary.
9. Access:
Access to the basin floor should be provided for light equipment.
10. Water Table:
The basin floor should be a minimum of 10 feet above the water table.
11. Maximum Depth:
The maximum allowable depth is equal to the infiltration rate

multiplied by the maximum allowable dewatering time (24hours).

12. Freeboard:

    A minimum of 2 feet of freeboard should be available between the spillway crest and the top of the basin (dam).

13. Emergency Spillway:

    The emergency spillway should be able to safely pass the 100-year Storm.

14. Surface Area of Basin Floor:

    If the surface area of the basin floor is increased, the infiltration rate and quantity of runoff which can be infiltrated will be increased. Increased surface areas can also help compensate for clogging on the surface.

BMP PC - 107

INFILTRATION TRENCHES

DESCRIPTION

An infiltration trench is an excavated trench that has been lined with filter fabric and backfilled with either stone or gravel to form underground storage. Runoff is diverted into the trench and either infiltrates into the soil, or enters a perforated pipe underdrain and is routed to an outflow facility. The depths of an infiltration trench generally range between 3 and 8 feet, and may change when site-specific factors are considered. Trenches are not usually feasible in ultra-urban or retrofit situations where the soils have low permeability or low void ratios. They should be installed only after the contributing area has stabilized to minimize runoff of sediments.

Infiltration trenches and infiltration basins follow similar design logic. The differences are that the former is for small drainage areas and stores runoff out of sight, within a gravel or aggregate matrix, whereas the latter is for larger drainage areas and water is stored in a visible surface pond.

Infiltration trenches effectively remove soluble and particulate pollutants. They can provide ground water recharge by diverting 60 to 90 percent of annual urban runoff back into the soil. They are generally used for drainage areas less than 10 acres, but
some references cite 5 acres as a maximum size drainage area. Potential locations include residential lots, commercial areas, parking lots and areas adjacent to road shoulders. Trenches are only feasible on permeable soils (sand and gravel), and where the water table and bedrock are situated well below the bottom of the trench. Trenches are frequently used in combination with grassed swales. Trenches should not be used to trap course sediments, as the larger sediment particles will clog the trench. Grass buffers can be installed to capture sediment before it enters the trench.

ADVANTAGES

1. Provides groundwater recharge.
2. Trenches fit into small areas.
3. Good pollutant removal capabilities.
4. Can minimize increases in runoff volume.
5. Can fit into medians, perimeters, and other unused areas of a development site.
6. Helps replicate pre-development hydrology and increases dry weather base flow.

LIMITATIONS

1. Slope of contributing watershed needs to be less than 20 percent.
2. Soil should have infiltration rate greater than 0.3 inches per hour and a clay content less than 30 percent.
3. Drainage area should be between 1 to 10 acres.
4. The bottom of the infiltration trench should be at least 4 feet above the underlying bedrock and the seasonal high water table.
5. High failure rates of conventional trenches and a high maintenance burden.
6. Low removal of dissolved pollutants in very coarse soils.
7. Not suitable on fill slopes or steep slopes.
8. Risk of ground water contamination in very coarse soils may require groundwater monitoring.
9. Infiltration facilities could fall under additional regulations of IDEM or IDNR regarding waste disposal to groundwater.
10. Cannot be located within 100 feet of drinking water wells.
11. Need to be located a minimum of 10 feet down gradient and 100 feet up gradient from building foundations because of potential seepage problems.
12. Should not be used if upstream sediment load cannot be controlled prior to entry into the trench.
13. Metals and petroleum hydrocarbons could accumulate in soils to potentially toxic levels.

DESIGN CRITERIA

Infiltration trenches can be categorized as either surface or below ground. Special inlets are required for underground trenches to prevent sediment and oil or grease from clogging the infiltration trench. Surface trenches are commonly used where land is not a limiting factor and underground trenches are better suited for developments with minimal land availability.

1. Volume:
   Calculate the volume of stormwater to be mitigated by the water quality volume calculation Chapter 8.
2. Dimensions:
   Generally, soils with low infiltration rates require a higher ratio of bottom surface area to storage volume. The following formulas can be used to determine the dimensions of the infiltration basin:

$$H(T\ max) = E(t\ max)/P$$

$$H(T\ min) = E(t\ min)/P$$

$$A = V/[\ E\ t\ max]$$

Where:

H T max, H T min = maximum and minimum trench depths (ft)

E = Infiltration rate in length per unit time (ft/hr)
t max, t min = maximum and minimum target drain time (hr)
P = Pore volume ratio of stone aggregate (% porosity/100)
V = Fluid storage volume requirement (cu ft)
A = Trench bottom surface area (sq ft)

The actual storage volume of the facility is the void ratio multiplied by the total volume of the trench. The available land and other constraints such as depth to bedrock or water table are used to determine the final dimensions of the trench.

3. Buffer Strip/Special Inlet:
A grass filter strip a minimum of 20 feet in width should surround the trench on all sides over which surface flow reaches an above ground trench. A special inlet can be used to prevent floatable materials, solids, grease, and oil from entering trenches which are located below ground.
4. Filter Fabric:
The bottom and sides of the trench should be lined with filter fabric soon after the trench is excavated. The fabric should be flush with the sides, overlap on the order of 2 feet over the seams, and not have trapped air pockets. As an alternative, six (6) inches of clean washed sand may be placed on the bottom of the trench instead of filter fabric.
5. Grass Cover:
If the trench is grass covered, at least 1 foot of soil should be over the trench for grass substrate.
6. Surface Area:
The surface area of the trench can be engineered to the site with the understanding that a larger surface area of the bottom of the trench increases infiltration rates and helps to reduce clogging and that depth may be limited by seasonal groundwater.
7. Surface Area of Trench Bottom:
Pollutant removal in a trench can be improved by increasing the surface area of the trench bottom. This is done by adjusting the geometry to make the trench shallow and broad, rather than deep and narrow. Greater bottom surface area increases infiltration rates and provides more area and depth for soil filtering. In addition, broader trench bottoms reduce the risk of clogging at the soil/filter cloth interface by spreading infiltration over a wider area.
8. Distance from Wells and Foundations:
The trench should be at least 100 feet from any drinking water supply well, and at least 10 feet down gradient and 100 feet up gradient from building foundations.
9. Drain Time:
The drain time should be between two and three days. The total volume of the trench should drain in 48 hours. The minimum drain time should be 24 hours.

10. Backfill Material:
    The backfill material in the trench should have a D(50) sized between 1.5 and 3 inches and the clay content should be limited to less than 30 percent. The porosity of the material should be between 0.3 and 0.4.
11. Observation Well:
    An observation well of four (4) to six (6) inches diameter PVC pipe should be located in the center of the trench and the bottom should rest on a plate. The top should be capped. The water level should be measured after a storm event. If the well has not completely drained in three days, some remedial work may need to be done.
12. Overflow Berm:
    A 2 to 3 inch emergency overflow berm on the down stream side of the trench serves a twofold purpose. First, it detains surface runoff and allows it to pond and infiltrate to the trench. Secondly the berm also promotes uniform sheet flow for runoff overflow.

MEDIA FILTRATION

DESCRIPTION OF SAND FILTERS

Media filters are two-stage constructed treatment systems, including a pre - treatment settling basin and a filter bed containing sand or other filter media. Various types of sand filter designs have been developed and implemented successfully in space-limited areas. The filters are not designed to treat the entire storm volume but rather the water quality volume (Chapter 8), that tends to contain higher pollutant levels. Sand filters can be designed so that they receive flow directly from the surface (via inlets or even as sheet flow directly onto the filter bed) or via storm drain pipes. They can be exposed to the surface or completely contained in underground pipe systems or vaults.

While there are various designs, most intermittent sand filters contain four basic components, as listed below:

1. Diversion Structure:
   Either incorporated into the filter itself or as a stand alone device, the diversion structure isolates the WQV and routes it to the filter. Larger volumes are bypassed directly to the storm drain system.
2. Sedimentation Chamber:
   Important to the long-term successful operation of any filtration system is the removal of large grained sediments prior to exposure to the filter media. The sedimentation chamber is typically integrated directly into the sand filter BMP but can also be a stand alone unit if space permits.
3. Filter Media:
   Filter media typically consists of a one (1) inch gravel layer over an 18 to 24 inch layer of washed sand. A layer of geotextile fabric can be placed between the gravel and sand layers.
4. Underdrain System:
   Below the filter media is a gravel bed, separated from the sand by a layer of geotextile fabric in which is placed a series of perforated pipes.

The treated runoff is routed out of the BMP to the storm sewer system or another BMP.

ADVANTAGES

1. May require less space than other treatment control BMPs and can be located underground.
2. Does not require continuous base flow.
3. Suitable for individual developments and small tributary areas up to 100 acres.
4. Does not require vegetation.
5. Useful in watersheds where concerns over ground water quality or site conditions prevent use of infiltration.
6. High pollutant removal capability.
7. Can be used in highly urbanized settings.
8. Can be designed for a variety of soils.
9. Ideal for aquifer regions.

LIMITATIONS

1. Given that the amount of available space can be a limitation that warrants the consideration of a sand filter BMP, designing one for a large drainage area where there is room for more conventional structures may not be practical.
2. Available hydraulic head to meet design criteria.
3. Requires frequent maintenance to prevent clogging.
4. Not effective at removing liquid and dissolved pollutants.
5. Severe clogging potential if exposed soil surfaces exist upstream.
6. Sand filters may need to be placed off line to protect it during extreme storm events.

DESIGN CRITERIA

1. Treatment Rate:
   Calculate the flow rate of storm water to be mitigated by the media filtration according to the method in Chapter 8.

2. Surface Area of the Filter:
   The following equation is for a maximum filtration time of 24 hours:

   A. Surface Systems or Vaults

   Filter area (sq ft) = 3630(Su)(AH) / K(D+H)

   Where:

   Su = unit storage (inches-acre)
   A = area in acres draining to facility
   H = depth (ft) of the sandfilter
   D = average water depth (ft) over the filter taken to be one-half the difference between the top of the filter and the maximum water surface elevation
   K = filter coefficient recommended as 3.5

   This equation is appropriate for filter media sized at a diameter of 0.02 to 0.04 inches. The filter area must be increased if a smaller media is used.

   B. Underground Sand Filter Systems

   1. Compute the requred size of the sand filter bed surface area, AF. The following equation is based on Darcy's law and is used to size the sand filter bed area.

   AF (sq ft) = 24(WQV)(df) / [k (hf + df) tf]

   Where;

   Af = sand filter bed surface area (sq ft)
   WQV = Water quality treatment volume (cu ft)

df = sand filter bed depth (ft)
k = filter coefficient recommended as 3.5 (ft/day)
hf = average height of water above the sand bed (ft) = (hmax/2)
hmax = elevation difference between invert of the inlet pipe and the top of the sand filter bed (ft)
tf = time required for the runoff to filter through the sand bed (hr) (Typically 24 hr)

Note: 24 in the equation is the 24 hr/day constant.

2. Choose a pipe size (diameter). The selection of pipe size should be based on site parameters such as: elevation of the runoff coming into the sand filter system, elevation of down stream connection to which the sand filter system outlet must tie into and the minimum cover requirements for live loads. A minimum of five (5) foot clearance should be provided between the top of the inner pipe wall and the top of the filter media for maintenance purposes.

Use:

$$D = d+5$$

Where ;

D = pipe diameter (ft)
d = depth of sand filter and underdrain pipe media depth(ft) = dg + df
dg = underdrain pipe media depth = 0.67 ft
df = sand filter bed depth (ft): 1.5 to 2.0 feet

3. Compute the sand filter width (based on the pipe geometry).

WF = 2 (square root)[R(squared) - R -d)(squared)]

Where:

Wf = filter width (ft)
R = pipe radius (ft)

4. Compute the filter length:

$$Lf = Af / Wf$$

Where:

Lf = filter length (ft)
Af = area of the filter (ft)
Wf = width of the filter (ft)

3. Configuration

A. Surface sand filter

Criteria for the settling basin:

1. For the outlet use a perforated riser pipe.
2. Size the outlet orifice for a 24 hour drawdown.
3. Energy dissipater at the inlet to the settling basin.
4. Trash rack at outlets to the filter.
5. Vegetate slopes to the extent possible.
6. Access ramp (4:1 or less) for maintenance vehicles.
7. One foot of freeboard.
8. Length to width ratio of at least 3 : 1 and preferably 5 : l.
9. Sediment trap at inlet to reduce resuspension.

Criteria for the filter:

1. Use a flow spreader.
2. Use clean sand 0.02 to 0.04 inch diameter.
3. Place geofabric on sand surface to facilitate maintenance.
4. Underdrains with:
    a. four (4) inch dia. Schedule 40 PVC pipe.

b. 3/8 inch perforations placed around the pipe, with six (6) inch spacing between the perforation clusters.
c. maximum 10 foot spacing between laterals.
d. minimum grade of 1/8 inch per foot.

B. Underground sand filter

Criteria for the settling tank (if required).

1. Use orifice and / or weir structure for the outlet.
2. Size the outlet orifice or weir for a 24 hour draw down time.
3. Provide access manhole for maintenance.

Criteria for the filter.

1. Use a flow spreader.
2. Use clean sand 0.02 to 0.04 inch diameter.
3. Place geofabric on sand surface to facilitate maintenance.
4. Underdrains with:
    a. 4 inch diameter Schedule 40 PVC pipe
    b. 3/8 inch perforations placed around the pipe, with six (6) inch spacing between the perforation clusters.
    c. Provide access manhole for maintenance.

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STORM DRAIN INSERTS

DESCRIPTION

Storm drain inserts can be a variety of devices that are used in storm drain conveyance systems to reduce pollutant loadings in stormwater runoff. Most storm drain inserts reduce oil and grease, debris, and suspended solids through gravity, centrifugal force, or other methods. BMPs such as these can be particularly useful in areas susceptible to spills of petroleum products, such as gas stations. Trapped sediments and floatable oils must be pumped out regularly to maintain the effectiveness of the units.

ADVANTAGES

1. Prefabricated for different standard storm drain designs.
2. Requires minimal space to install.

LIMITATIONS

1. Some devices may be vulnerable to accumulated sediments being re-suspended during heavy storms.
2. Can only handle limited amounts of sediment and debris.
3. Maintenance and inspection of storm drain inserts are required before and after each rainfall event.
4. High maintenance costs.
5. Hydraulic losses.

DESIGN CRITERIA

1. Calculate the minimum flow rate to be mitigated by the storm drain insert using the methods of Chapter 8.
2. Select unit which meets 80% TSS removal for design flow rate.
3. Provide an overflow to bypass flows greater than the water quality treatment rate.

BMP PC -110

VEGETATION FILTER STRIPS

DESCRIPTION

Vegetated filter strips, also known as vegetated buffer strips, are vegetated sections of land similar to grassed swales, except they are essentially flat with low slopes, and are designed only to accept runoff from overland sheet flow They may appear in any vegetated form from grassland to forest, and are designed to intercept upstream flow, lower flow velocity, and spread water out as sheet flow The dense vegetative cover facilitates conventional pollutant removal through detention,
filtration by vegetation, and infiltration into soil. Wooded and grass filter strips have slightly higher removal rates. Dissolved nutrient removal for either type of vegetative cover is usually poor, however wooded strips show slightly higher removal due to increased retention and sequestration by the plant community (Florida Department of Transportation, 1994).

Although an inexpensive control measure, they are most useful in contributing watershed areas where peak runoff velocities are low, as they are unable to treat the high flow velocities typically associated with high impervious cover. Similar to grassed swales, filter strips can last for l0 to 20 years with proper conditions and regular maintenance. Life expectancy is significantly diminished if uniform sheet flow and dense vegetation are not maintained.

ADVANTAGES

1. Lowers runoff velocity.
2. Slightly reduces runoff volume.
3. Slightly reduces watershed imperviousness.
4. Slightly contributes to ground water recharge.
5. Aesthetic benefit of vegetated "open spaces.
6. Preserves the character of riparian zones, prevents erosion along streambanks, and provides excellent urban wildlife habitat.

LIMITATIONS

1. Filter strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to pre-development levels for design storms. This lack of quantity control dictates use in rural or low density development.
2. Requires slopes less than 5%.
3. Requires low to fair permeability of natural subsoil.
4. Large land requirement.
5. Often concentrates water, which significantly reduces effectiveness.
6. Pollutant removal is unreliable in urban settings.

DESIGN CRITERIA

1. Successful performance of filter strips relies heavily on maintaining shallow unconcentrated flow. To avoid flow channelization and maintain performance, a filter strip should:

   a. Be equipped with a level spreading device for even distribution of runoff,
   b. Contain dense vegetation with a mix of erosion resistant, soil binding species.
   c. Be graded to a uniform, even and relatively low slope.
   d. Laterally traverse the contributing runoff area.
   e. The area to be used for the strip should be free of gullies or rills that can concentrate overland flow.
   f. Filter strips should be placed three (3) to four (4) feet from edge of pavement to accommodate a vegetation free zone. The top edge of the filter strip along the pavement should be designed to avoid the situation where runoff would travel along the top of the filter strip, rather than through it. Berms should be placed at 50 to 100 feet intervals perpendicular to the top edge of the strip to prevent runoff bypassing.

g. Top edge of the filter strip should follow the same elevation contour. If a section of the edge of the strip dips below the contour, runoff will tend to form a channel toward the low spot.

h. Filter strips should be landscaped after other portions of the project are completed. However, level spreaders and strips used as sediment control measures during the construction phase can be converted to permanent controls if they can be regraded and re-seeded to the top edge of the strip.

2. Filter strips can be used on an up gradient from watercourses, wetlands, or other water bodies, along toes and tops of slopes, and at outlets of other stormwater management structures. They should be incorporated into street drainage and master drainage planning. The most important criteria for selection and use of this BMP are soils, space and slope, where:

   a. Soils and moisture are adequate to grow relatively dense vegetative stands:
   Underlying soils should be of low permeability so that the majority of the applied water discharges as surface runoff. The range of desirable permeability is between 0.06 to 0.6 inches per hour. Common soil textural classes are clay, clay loam, and silty clay. The presence of clay and organic matter in soil improves the ability of filter strips to remove pollutants from the surface runoff. Greater removal of soluble pollutants can be achieved where the water table is within three (3) feet of the surface (i.e., within the root zone). Filter strips function most effectively where the climate permits year-round dense vegetation

   b. Sufficient space is available:
   Because filter strip effectiveness depends on having an evenly distributed sheet flow, the size of the contributing area and the associated volume runoff have to be limited. To prevent concentrated flows from forming, it is advisable to have each filter strip serve a contributing area of five acres or less.

When used alone, filter strip application is in areas where impervious cover is low to moderate and where there are small fluctuations in peak flow.

c. Longitudinal slope is five percent or less:
When filter strips are used on steep or unstable slopes, the formation of rills and gullies can disrupt sheet flow. As a result filter strips will not frurction at all on slopes greater than 15 percent and may have reduced effectiveness on slopes between 6 to 15percent.

3. The design should be based on the same methods detailed for swales. The preferred geometry of a filter strip is rectangular, and this should be used when applying the design procedures of vegetated swales.

4. The following provisions apply specifically to filter strips:

   a. Slopes should be no greater than 15 percent and should preferably be lower than 5 percent, and be uniform throughout the strip after final grading.
   b. Hydraulic residence time normally should be no less than 9 minutes and in no case less than 5 minutes.
   c. Average velocity no greater than 0.9 feet/second.
   d. Manning's friction factor (n) of 0.02 should be used for grassed strips; n of 0.024 if strip is infrequently mowed, or a selected higher value if the strip is wooded.
   e. The width should be no greater than that where a uniform flow distribution can be assured.
   f. Average depth of flow (design depth) should be no more than 0.5 inches.
   g. Hydraulic radius is taken to be equal to the design flow depth.
   h. A minimum of 8 feet is recommended for filter strip width.

5. Filter strips function best with longitudinal slopes less than 10 percent and ideally less than 5 percent. As filter strip length becomes shorter,

slope becomes more influential. Therefore, when a minimum strip length of 20 feet is utilized, slopes should be graded as close to zero as drainage permits. With steeper slopes, terracing through the use of landscape timber, concrete weirs, or other constructed means may be required to maintain sheet flow.

6. Calculate the flow rate of stormwater to be mitigated by the vegetated filter strip using the method outlined in Chapter 8.

7. Another design issue is runoff collection and distribution to the strip, and release to a transport system or receiving water. Flow spreader devices should be used to introduce the flow evenly to the filter strip. Concentrated flow needs to use a level spreader to evenly distribute flow onto a strip. There are many alternative spreader devices, with the main consideration being that the overland flow spreader be distributed equally across the strip. Level spreader options include porous pavement strips, stabilized turf strips, slotted curbing, rock-filled trench, concrete sills, or plastic-lined trench that acts as a small detention pond. The outflow and filter side lip of the spreader should have a zero slope to ensure even runoff distribution. Once in the filter strip, most runoff from significant events will not be infiltrated and will require a collection and conveyance system. Grass-lined swales are often used for this purpose and can provide another BMP level. A filter strip can also drain to a storm sewer or street gutter.

8. Filter strips should be constructed of dense, soil-binding deep-rooted water resistant plants. For grassed filter strips, dense turf is needed to promote sedimentation and entrapment ,and to protect against erosion. Turf grass should be maintained to a blade height of two (2) to four (4) inches. Most engineered, sheet-flow systems are seeded with specific grasses. The grass species chosen should be appropriate for the climatic conditions and maintenance criteria for each project.

9. Trees and woody vegetation have been shown to increase infiltration

and improve performance of filter strips. Trees and shrubs provide many stormwater management benefits by intercepting some rainfall before it reaches the ground, and improving infiltration and retention through the presence of a spongy, organic layer of materials that accumulates underneath the plants. As discussed previously in this section, wooded strips have shown significant increases in pollutant removal over grass strips. Maintenance for wooded strips is virtually non-existent. However, there are drawbacks to using woody plants. Since the density of the vegetation is not as great as a turf grass cover, wooded filter strips need additional length to accommodate more vegetation. In addition, shrub and tree trunks can cause uneven distribution of sheet flow, and increase the possibility for development of gullies and channels. Consequently, wooded strips require flatter slopes than a typical grass cover strip to ensure that the presence of heavier plant stems will not facilitate channelization.

BMP PC - 111

VEGETATIVE SWALE

DESCRIPTION

Vegetated swales are shallow vegetated channels to convey stormwater where pollutants are removed by filtration through grass and infiltration through soil. They look similar to, but are wider than, a ditch that is sized only to transport flow. They require shallow slopes and soils that drain well. Grassed swale designs have achieved mixed performance in pollutant removal efficiency. Moderate removal rates have been reported for suspended solids and metals associated with particulates such as lead and zinc. Runoff waters are typically not detained long enough to effectively remove very fine suspended solids, and swales are generally unable to remove significant amounts of dissolved nutrients. Pollutant removal capability is related to channel dimensions, longitudinal slope and type of vegetation. Optimum design of these components will increase contact time of runoff through the swale and improve pollutant removal rates. Vegetated swales are primarily storm water conveyance systems. They can provide sufficient control under light to moderate runoff conditions, but their ability to control large storms is limited. They are most applicable in low to moderate sloped areas as an alternative to ditches and curb and gutter drainage. Their performance diminishes sharply in highly urbanized settings. Vegetated swales are often used as a pretreatment measure for other downstream BMPs, particularly infiltration devices.

Enhanced vegetative swales utilize check dams and wide depressions to increase runoff storage and promote greater settling of pollutants.

ADVANTAGES

1. Relatively easy to design, install and maintain.
2. Vegetated areas that would normally be included in the site layout, if designed for appropriate flow patterns, may be used as a vegetated swale.

3. Relatively inexpensive.
4. Vegetation is usually pleasing to residents.

LIMITATIONS

1. Irrigation may be necessary to maintain vegetative cover.
2. Potential for mosquito breeding areas.
3. Possibility of erosion and channelization over time.
4. Requires dry soils with good drainage and high infiltration rates for better pollutant removal.
5. Not appropriate for pollutants toxic to vegetation.
6. Large area requirements may make this BMP infeasible for some sites.
7. Used to serve sites less than 10 acres in size, with slopes no greater than 5 percent.
8. The seasonal high water table should be at least two (2) feet below the surface.
9. Buildings should be at least ten (10) feet from the top of bank.

DESIGN CRITERIA

Several criteria should be kept in mind when beginning swale design. These provisions, presented below, have been developed through a series of evaluative research conducted on swale performance.

CRITERIA FOR OPTIMUM SWALE PERFORMANCE

PARAMETER	OPTIMAL CRITERIA	MINIMUM CRITERIA*
Hydraulic Residence Time	9 min	5 min
Average Flow Velocity	less than or equal to 0.9 ft / sec	greater than 0.1 ft / sec
Swale Width	8 ft	2 ft
Swale Length	200 ft	100 ft
Swale Slope	2 % to 6 %	1 %
Side Slope Ratio	4 : 1	2 : 1

Note. * Criteria at or below minimum values can be used when compensatory adjustments are made to the standard design. Specific guidance on implementing these adjustments are discussed in the design section.

The following steps are recommended to be conducted in order to complete a swale design:

1. Determine the flow rate to the system.
2. Determine the slope of the system.
3. Select a swale shape (skip if filter strip design).
4. Determine required channel width.
5. Calculate the cross-sectional area of flow for the channel.
6. Calculate the velocity of channel flow.
7. Calculate swale length.
8. Select swale location based on the design parameters.
9. Select a vegetation cover for the swale.
10. Check for swale stability.

Recommended procedures for each task:

1. Determine Flow Rate to the System:
   Calculate the flow rate of stormwater to be mitigated by the vegetated swale using the methods outlined in Chapter 8. Runoff from larger events should be designed to bypass the swale, consideration must be given to the control of channel erosion and destruction of vegetation. A stability analysis for larger flows (up to the 100-yr 24-hour) must be performed. If the flow rate approaches or exceeds 1 cu ft/sec, one or more of the design criteria above may be violated, and the swale system may not function correctly. Alternative measures to lower the design flow should be investigated. Possibilities include dividing the flow among several swales, installing detention to
   control release rate upstream, and reducing developed surface area to reduce runoff coefficient value and gain space for biofiltration.

2. Determine the Slope of the System:
The slope of the swale will be somewhat dependent on where the swale is placed, but should be between the stated criteria of between one (1) and six (6) percent.

3. Select a Swale Shape:
Normally, swales are designed and constructed in a trapezoidal shape, although alternative designs can be parabolic, rectangular, and triangular. Trapezoidal cross-sections are preferred because of relatively wider vegetative areas and ease of maintenance. They also avoid the sharp corners present in V-shaped and rectangular swales, and offer better stability than the vertical walls of rectangular swales.

4. Determine Required Channel Width:
Estimates for channel width for the selected shape can be obtained by applying Manning's Equation:

$$Q = 1.486 / n \, (AR \quad S)$$

Where:

Q = Flow (cu ft/sec)
A = Cross-sectional area of flow (sq ft)
R = Hydraulic radius of flow cross section (ft)
S = Longitudinal slope of biofilter (ft / ft)
n = Manning's roughness coefficient.

A Manning's n value of 0.02 is used for routine swales that will be mowed with some regularity. For swales that are infrequently mowed, use a Manning's n value of 0.024. A higher n value can be selected if it is known that vegetation will be very dense.

Because the channel is wide, the hydraulic radius approaches the flow depth. Substituting the geometric equations for a trapezoidal channel into Manning's equation, the bottom width (wb) and the top width (wt)
for the trapezoid swale can be computed using the following equations.

$$wb = Qn / 1.486\ S\ - Zy \quad \text{and} \quad wt = wb + 2\ Zy$$

Where:

Q = flow rate in cu ft/sec
n = Manning's roughness coefficient
y = Depth of flow. (ft)
Z = The side slope in the form of Z : l.

Typically, the depth of flow in the channel (y) is set at three (3) to four (4) inches. Flow depth can also be determined by subtracting two (2) inches from the expected grass height, if the grass type is known and the height it is to be maintained is known. Values lower than three (3) to four (4) inches can be used, but doing so will increase the computed width of the swale. Swale width should be between two (2) to eight (8) feet. Swales wider than eight (8) feet are more susceptible to flow channelization and are less likely to have uniform sheet flow across the swale bottom for the entire swale length. The maximum widths for swales are on the order of 10 feet; however, widths greater than 8 feet should be evaluated to consider the effectiveness of the flow spreading design used and the likelihood of maintaining evenness in the swale bottom. Since length may be used to compensate for width reduction (and vice versa) so that area is maintained, the swale width can be arbitrarily set to 8 feet to continue with the analysis.

5. Calculate Cross-Sectional Area:
Compute the cross-sectional area (A) for the swale.

6. Calculate the velocity of the Channel Flow.
Channel flow velocity (V) can be computed using the continuity equation:

$$V\ (ft/sec) = Q(cu\ ft/sec)\ /\ A(sq\ ft)$$

This velocity should be less than 0.9 ft/sec, a velocity that was found to cause grasses to be flattened, reducing filtration. A velocity lower than
this maximum value is recommended to achieve the 9-minute hydraulic residence time criterion, particularly in shorter swales. At V = 0.9 ft/sec, a 485 ft swale is needed for a 9 minute residence time and a 269 ft swale would be required for a 5 minute residence time.
If the value of V suggests that a longer swale will be needed than space permits, investigate how the design flow Q can be reduced, or increase flow depth(y) and/or swale width (wt) up to the maximum allowable values and repeat the analysis.

7. Calculate Swale Length:
Compute the swale length (L) using the following equation:

$$L = 60Vtr$$

Where:

L = Length required to achieve residence time (ft)
tr = Hydraulic residence time (in minutes). *
V = Velocity of channel flow (ft/sec)

*Use fr = 9 min for this calculation.

If a swale length greater than the space will permit results, investigate how the design flow (Q) can be reduced. Increase flow depth (y) and/or swale width (wb) up to the maximum allowable values and repeat the analysis. If all of these possibilities are checked and space is still insufficient, (tr) can be reduced, but to no less than 5 minutes. If the computation results in (L) less than 100 ft, set (L) = 100 ft and investigate possibilities in width reduction. This is possible through recalculating (V) at the 100-ft length, re-computing cross-sectional area, and ultimately adjusting the swale width (wb) using the appropriate equation.

8. Select Swale Location:
Swale geometry should be maximized by the designer, using the above equations, and given the area to be utilized. If the location has not yet been chosen, it is advantageous to compute the required swale dimensions and then select a location where the calculated width and length will fit. If locations available cannot accommodate a linear swale, a wide-radius curved path can be used to gain length. Sharp bends should be avoided to reduce erosion potential. Regardless of when and how site selection is performed, consideration should be given to the following site criteria:

   a. Soil Type: Soil characteristics in the swale bottom should be conducive to grass growth. Soils that contain large amounts of clay cause relatively low permeability and result in standing water, and may cause grass to die. Where the potential for leaching into groundwater exists, the swale bottom may need to be sealed with clay to protect from infiltration into the resource. Compacted soils will need to be tilled before seeding or planting If topsoil is required to facilitate grass seeding and growth, use six (6) inches of the following recommended topsoil mixture: 50 to 80 percent sandy loam, 10 to 20 percent clay and l0 to 20 percent composted organic matter (exclude animal waste).

   b. Slope: The natural slope of the potential location will determine the nature and amount of regrading, or if additional measures to reduce erosion and/or increase pollutant removal are required. Swales should be graded carefully to attain uniform longitudinal and lateral slopes and to eliminate high and low spots. If needed, grade control checks should be provided to maintain the computed longitudinal slope and limit maximum flow velocity.

c. Natural Vegetation: The presence and composition of existing vegetation can provide valuable information on soil and hydrology. If wetland vegetation is present, inundated conditions may exist at the site. The presence of larger plants, trees and shrubs, may provide additional stabilization along the swale slopes, but also may shade any grass cover established. Most grasses grow best in full sunlight, and prolonged shading should be avoided. It is preferable that vegetation species be native to the region of application, where establishment and survival have been demonstrated.

9. Select Vegetative Cover:
A dense planting of grass provides the filtering mechanism responsible for water quality treatment in swales. In addition, grass has the ability to grow through thin deposits of sediment and sand, stabilizing the deposited sediment and preventing it from being re-suspended in runoff waters. Few other herbaceous plant species provide the same density and surface per unit area. Grass is by far the most effective choice of plant material in swales; however, not all grass species provide optimum vegetative cover for use in swale systems. Dense turf grasses are best for vegetative cover. In areas of poor drainage, wetland species can be planted for increased vegetative cover. Use wetland species that are finely divided and relatively resilient such as grasses. Invasive species, such as cattails, should be avoided to eliminate proliferation in the swale and downstream. Woody or shrubby plantings can be used for landscaping on the top edge of side slopes, but not in the swale treatment area. Trees and shrubs can provide some additional stabilization, but trees mature and provide too much shade for the grasses. In addition, leaves and needles can contribute to debris jams

and interfere with water flow through the system. If landscape plantings are to be used, selection and planting processes should be carefully planned and carried out to avoid these potential problems.

10. Check Swale Stability:
The stability check is performed for the combination of highest expected flow and least vegetation cover and height. Stability is normally checked for flow rate (Q) for the 100 - year, 24 hour storm unless runoff from larger such events will by-pass the swale. (Q) can be determined by using the same methods mentioned for the design storm computation. Maximum velocity (Vmax) permissible for the vegetation type, slope and soil conditions should be obtained.

BMP PC - 112

WET PONDS

DESCRIPTION

The wet pond or retention pond is a facility which removes sediment ,biochemical oxygen demand (BOD) organic nutrients and trace metals from stormwater runoff. This is accomplished by slowing down stormwater using an in-line permanent pool or pond effecting settling of pollutants. The wet pond is similar to a dry pond, except that a permanent volume of water is incorporated into the design. The drainage area should be such that an adequate base flow is maintained in the pond. Biological processes occurring in the permanent pond pool aid in reducing the amount of soluble nutrients present in the water, such as nitrate and ortho-phosphorus.

The basic elements of a wet pond are outlined below. A stabilized inlet prevents erosion at the entrance to the pond. It may be necessary to install energy dissipaters. The permanent pool is usually maintained at a depth of between three (3) and eight (8) feet. The shape of the pool can help improve the performance of the pond. Maximizing the distance between the inlet and outlet provides more time for mixing of the new runoff with the pond water and settling of pollutants. Overflow from the pond is released through outlet structures to discharge flows at various elevations and peak flow rates. The outfall channel should be protected to prevent erosion from occurring downstream of the outlet.

Soil conditions are important for the proper functioning of the wet pond. The pond is a permanent pool, and thus must be constructed such that the water must not be allowed to exfiltrate from the permanent portion of the pool. It is difficult to form a pool in soils with high exfiltration rates soon after construction. Eventually, however, deposition of silt at the bottom of the pond will help slow exfiltration. If extremely permeable soils exist at the site (hydrologic soil group A or B), a geotextile or clay liner may be necessary.

ADVANTAGES

1. Wet ponds have recreational and aesthetic benefits due to the incorporation of
permanent pools in the design.
2. Wet ponds offer flood control benefits in addition to water quality benefits.
3. Wet ponds can be used to handle large drainage areas.
4. High pollutant removal efficiencies for sediment. total phosphorus and total nitrogen are achievable when the volume of the permanent pool is at least three (3) times the water quality volume (the volume to be treated).
5. A wet pond removes pollutants from water by both physical and biological processes, thus they are more effective at removing pollutants than extended dry detention basins.
6. Creation of aquatic and terrestrial habitat.

LIMITATIONS

1. Wet ponds may be feasible for stormwater runoff in residential or commercial areas with a combined drainage area greater than 20 acres but no less than 10 acres.
2. An adequate source of water must be available to ensure a permanent pool throughout the entire year.
3. If the wet pond is not properly maintained or the pond becomes stagnant; floating debris, scum, algae blooms, unpleasant odors, and insects may appear.
4. Sediment removal is necessary every 5 to 10 years.
5. Heavy storms may cause mixing and subsequent re-suspension of solids.
6. Evaporation and lowering of the water level can cause concentrated levels of salt and algae to increase.

7. Cannot be placed on steep unstable slopes.
8. Could be regulated as a wetlands or Waters of the US by IDEM.
9. Embankment may be regulated as a dam by IDNR.

DESIGN CRITERIA

1. Hydrology: If the device will also be used for stormwater quantity control, it will be necessary to reduce the peak flows after development to the levels described in Chapter 5.

2. Volume: Calculate the volume of stormwater to be mitigated by the wet pond using the water quality volume calculations in Chapter 8. The volume of the permanent pool should be 3 times this water quality volume.

3. Pond Shape: The pond should be long and narrow and generally shaped such that it discourages "short-circuiting". Short-circuiting occurs when storm flows by-pass the pond and do not mix well with the pool. Short-circuiting can be discouraged by lengthening the pond or by installing baffles which slow water down and lengthen the distance between the inlet and outlet A length to width ratio of no less than 2 : 1, with 4 : 1 being preferred, will help minimize short circuiting. Also, the pond should gradually expand from the inlet and gradually contract toward the outlet.

4. Depth: The depth of the water quality pond is important in the design of the pond. If the pond is too shallow, sediment will be easily re-suspended as a result of wind. Shallow ponds should not be used unless vegetation is adequate to stabilize the pond. If the pond is too deep, safety considerations emerge and stratification may occur, possibly causing anoxic conditions near the bottom of the pond. If the pond becomes anoxic, pollutants adsorbed to the bottom sediments may be released back to the water column. The average depth should

be three (3) to six (6) feet, and depths of more than eight (8) feet should be avoided. A littoral zone of six (6) to 18 inches deep that accounts for 25 to 50 percent of the permanent pool surface for plant growth along the perimeter of the pool is recommended, the littoral shelf will also enhance safety.

5. Vegetation: Planting vegetation around the perimeter of the pond can have several advantages. Vegetation reduces erosion on both the side slopes and the shallow littoral areas. Vegetation located near the inlet to the pond can help trap sediments; algae growing on these plants can also filter soluble nutrients in the water column. Thicker, higher vegetation can also help hide any debris which may collect near the shoreline. Native turf-forming grasses or irrigated turf should be planted on sloped areas, and aquatic species should be planted on the littoral areas. Vegetation can benefit wildlife and waterfowl by providing food and cover at the marsh fringe. A shallow, organic-rich marsh fringe provides an area which enables bacteria and other microorganisms to reduce organic matter and nutrients.

6. Side Slopes: Gradual side slopes of a wet pond enhance safety and help prevent erosion and make it easier to establish dense vegetation. If vegetation cannot be established, the un-vegetated banks will add to erosion and subsequently the sediment load. It is recommended that side slopes be no greater than 3 : 1. For slopes steeper than 3 : 1, riprap should be used to stabilize the banks.

7. Hydraulic Devices: An outlet device, typically a riser-pipe barrel or modified "Type - P" structure system, should be designed to release runoff in excess of the water quality volume and to control storm peaks. The outlet device should still function properly when partial clogging occurs. Plans should provide details on all pipes, culverts, risers and spillways. Calculations should depict inflow, storage and

outflow characteristics of the design. Frequently used designs for extending detention times in wet ponds are:

a. Slotted standpipe from low-flow orifice, inlet control (dry pond, shallow wet pond, or shallow marsh). An "L'"-shaped PVC pipe is attached to the low-flow orifice. An orifice plate is located within the PVC pipe which internally controls the release rate. Slots or perforations are all spaced vertically above the orifice plate so that sediment deposited around the standpipe will not impede the supply of water to the orifice plate.

b. Negatively sloped pipe from stream or outlet drain. (wet ponds or shallow marshes) This design was developed to allow for extended detention in wet ponds. The release rate is governed merely by the size of the pipe. The risk of clogging is largely eliminated by locating the opening of the pipe at least 1 foot below the water surface where it is away from floatable debris. Also, the negative slope of the pipe reduces the chance that debris will be pulled into the opening by suction. As a final defense against clogging, the orifice can be protected by wire mesh.

c. Hooded riser (wet ponds). In this design, the extended detention orifice is located on the face of the riser near the top of the permanent pool elevation. The orifice is protected by wire mesh and a hood, which prevents floatable debris from clogging the orifice.

d. A modified Indiana Department of Highways "Type - P" structure. The structure can be placed with the inlet grating below the normal pool elevation so insure floatables do not impede the outflow of water. Often times a weir is constructed inside the structure to prevent fish from entering the pipe outleting the structure. A sump may also be installed to prevent debris and sediments from entering the downstream outlet.

8. Inlet and Outlet Protection: The inlet pipe should discharge at or below the water surface of the permanent pool. If it is above the pool,

an outlet energy dissipater will protect the banks and side slopes of the pond to avoid erosion. The stream channel just down stream of the pond outlet should be protected from scouring by placing riprap along the channel. Also, the slope of the outlet channel should be close to 0.5 percent. Riprap between 9 to 12 inches in size should be used if the outlet pipe is less than 24 inches in diameter. Stilling basins may also be installed to reduce flow velocities at the outfall.

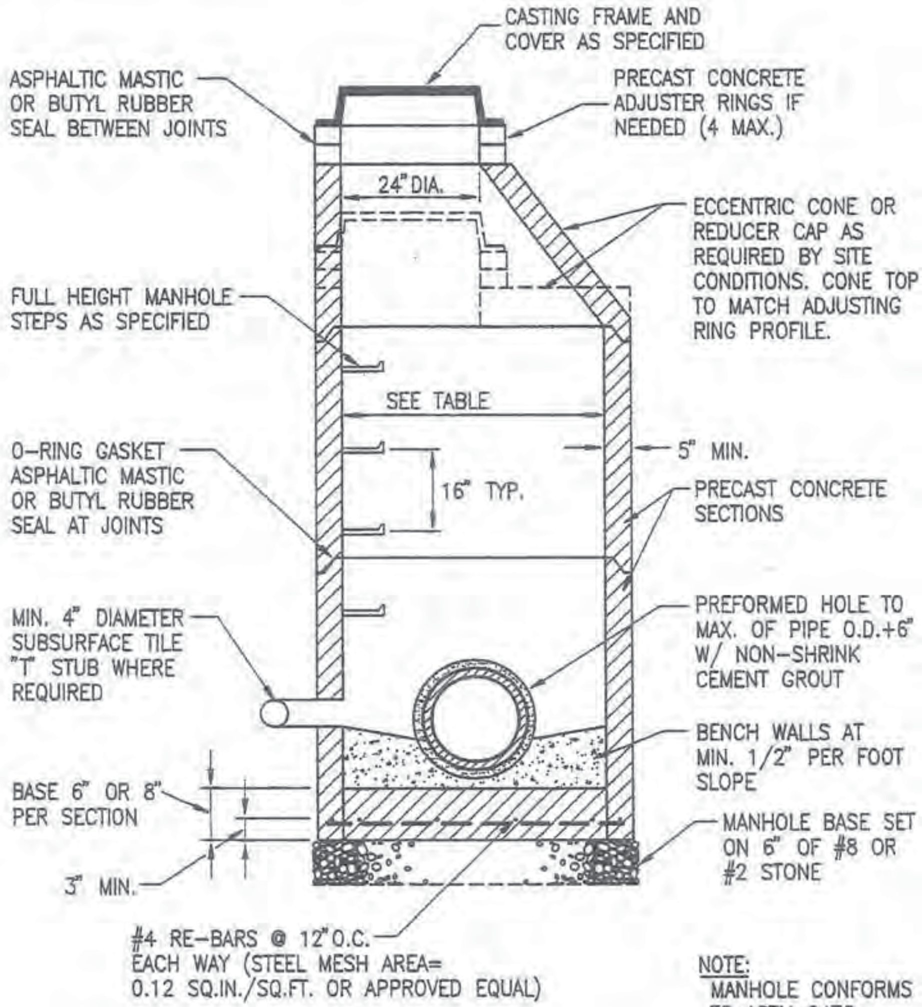
9. Forebay; A forebay may be installed as part of the wet pond to capture sand and gravel sediment. The forebay should be easily accessible for dredging out the sediment when necessary and access to the forebay for equipment should be provided. The forebay volume should typically be 5 to 10 percent of the water quality volume. If there are multiple inlets to the detention facility, each forebay should be sized based on the portion of water quality volume attributed to the particular inlet.

10. Emptying Time: A 12 to 48 hour emptying time may be used for the water quality volume above the permanent pool.

11. Freeboard: The pond embankment should have at least one (1) foot of freeboard above the emergency spillway crest elevation.

Appendix E

STANDARD CONSTRUCTION DETAILS



NOTE:
MANHOLE CONFORMS
TO ASTM C478

Pipe Size	*Pipes entering or leaving at a 0-45 degree angle*	*Pipes entering or leaving at a 46-90 degree angle*
12"-21"	**48"**	**48"**
24"	**48"**	**60"**
27" - 30"	**60"**	**60"**
33" - 36"	**60"**	**72"**

STORM MANHOLE FOR 12" THRU 24" PIPES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ____________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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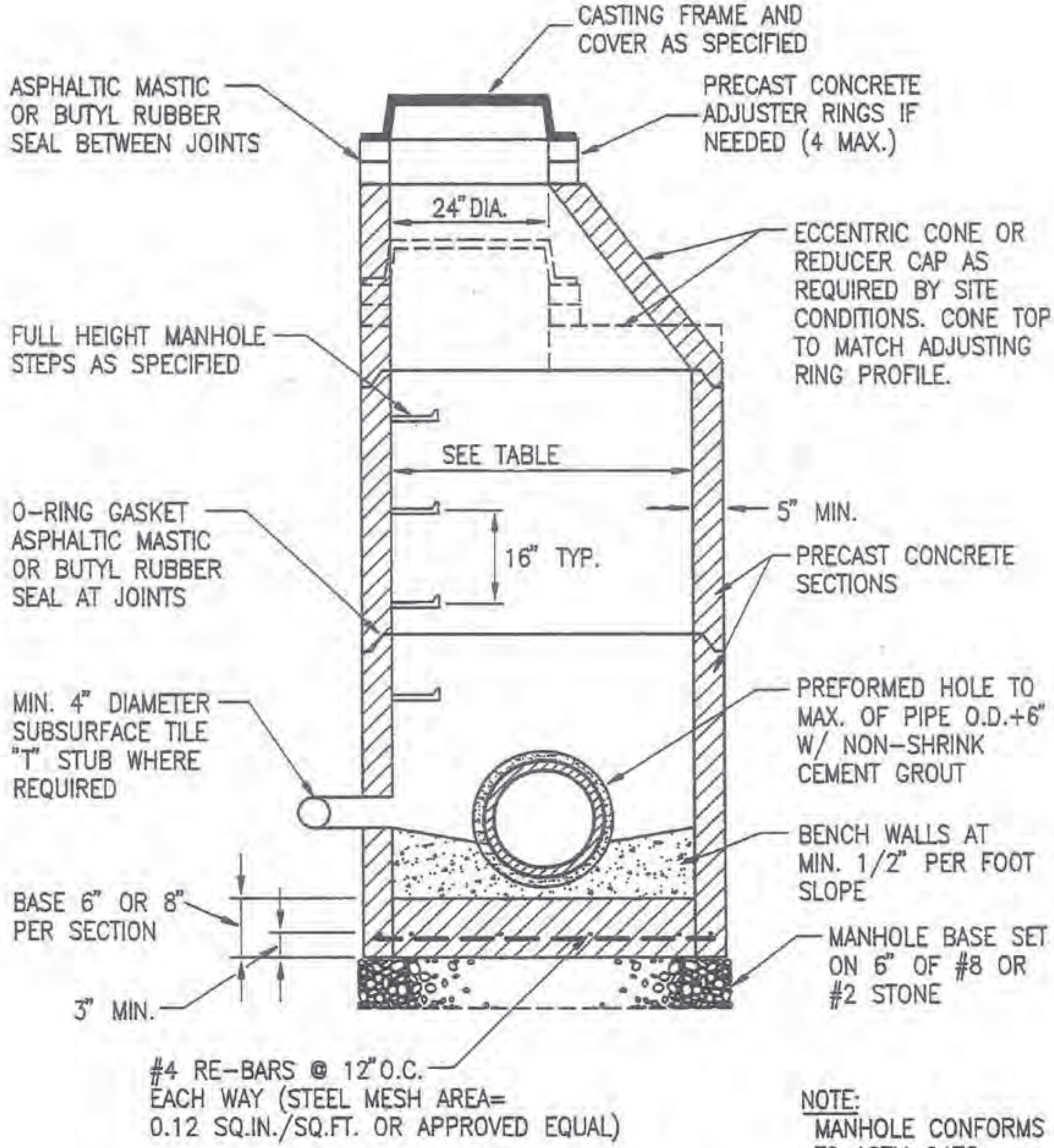
REVISED: ____________

STANDARD DETAIL

12-24STORM-MH.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



NOTE:
MANHOLE CONFORMS TO ASTM C478

STORM MANHOLE FOR 27" THRU 48" PIPES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ ________
MADISON COUNTY ENGINEER DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________
DATE

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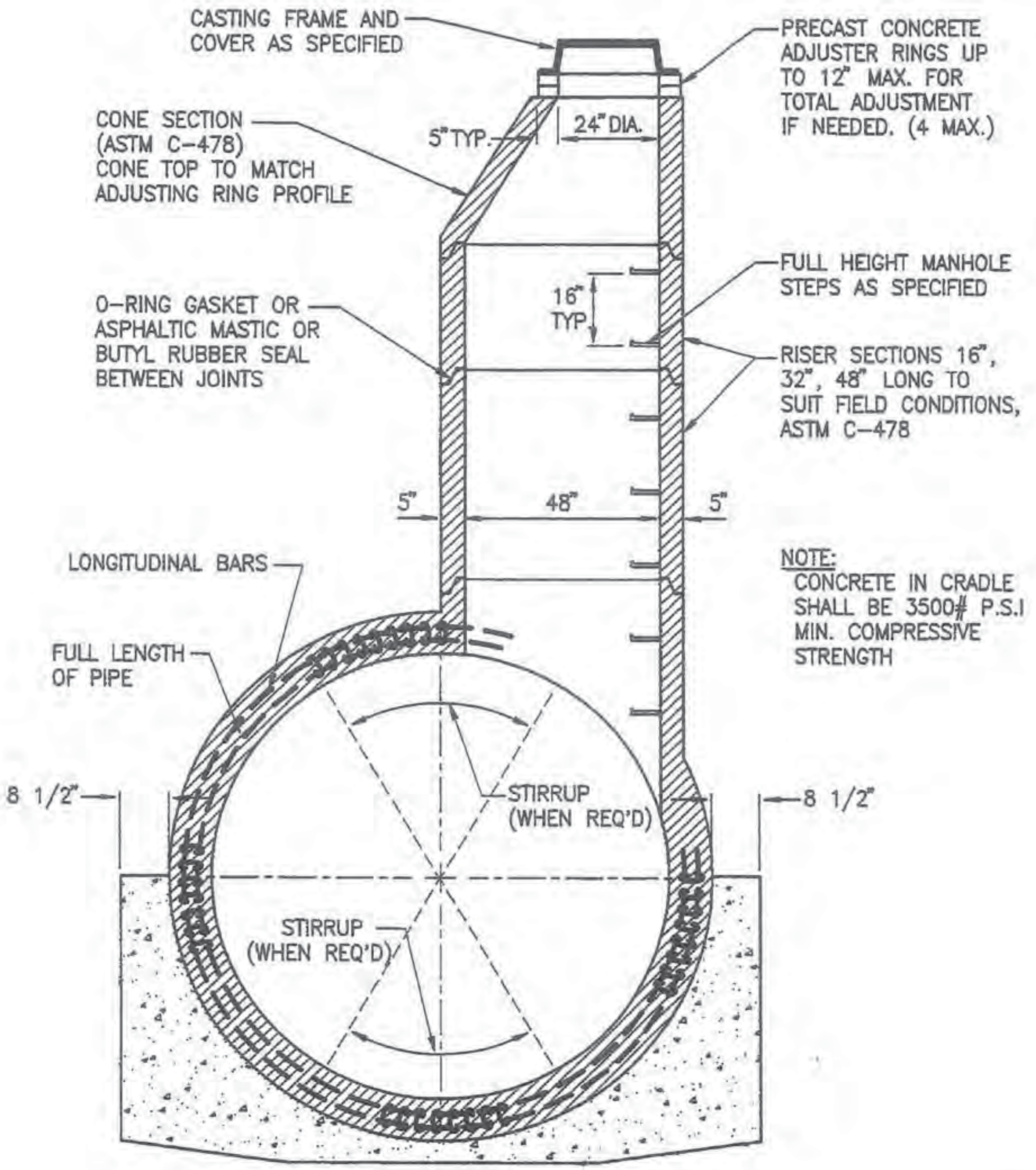
REVISED: ______________________

STANDARD DETAIL

27-48STORM-MH.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



STORM MANHOLE FOR 54" THRU 144" PIPES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

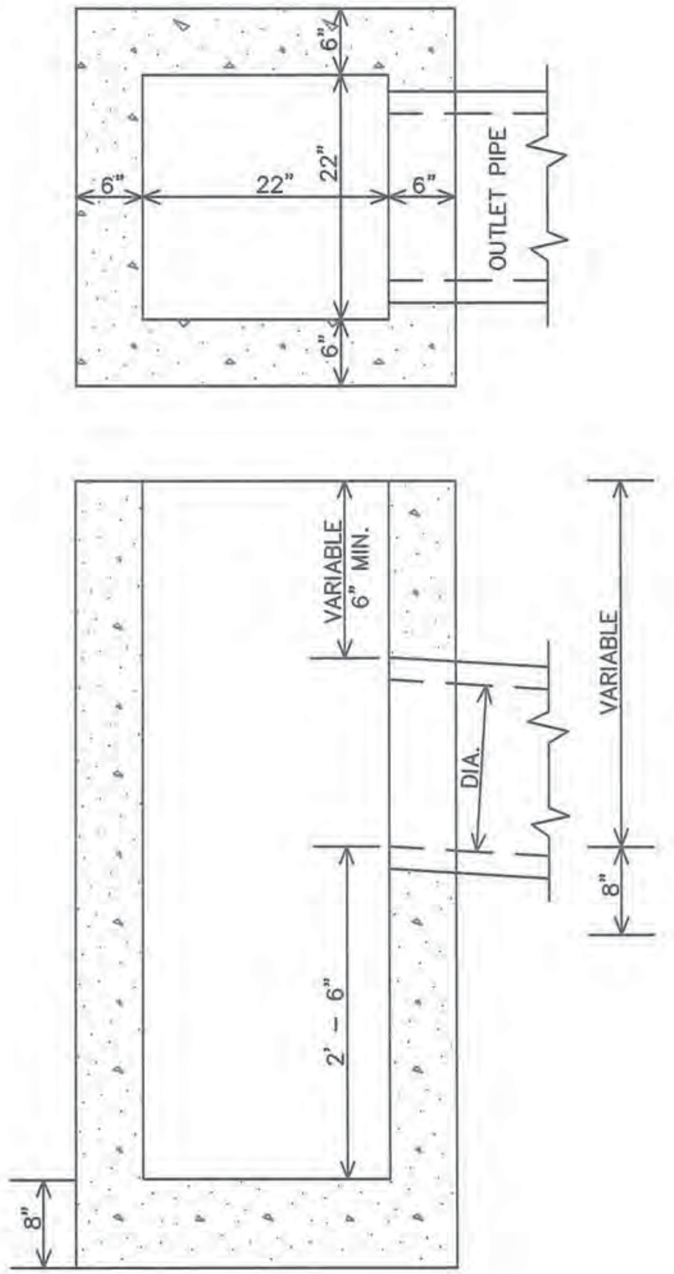
APPROVED: ______________________ ______
MADISON COUNTY ENGINEER DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______
DATE

REVISED: ______________

STANDARD DETAIL

54-144STORM-MH.DWG



TYPE "A" CATCH BASIN
(12" TO 15" PIPES)

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

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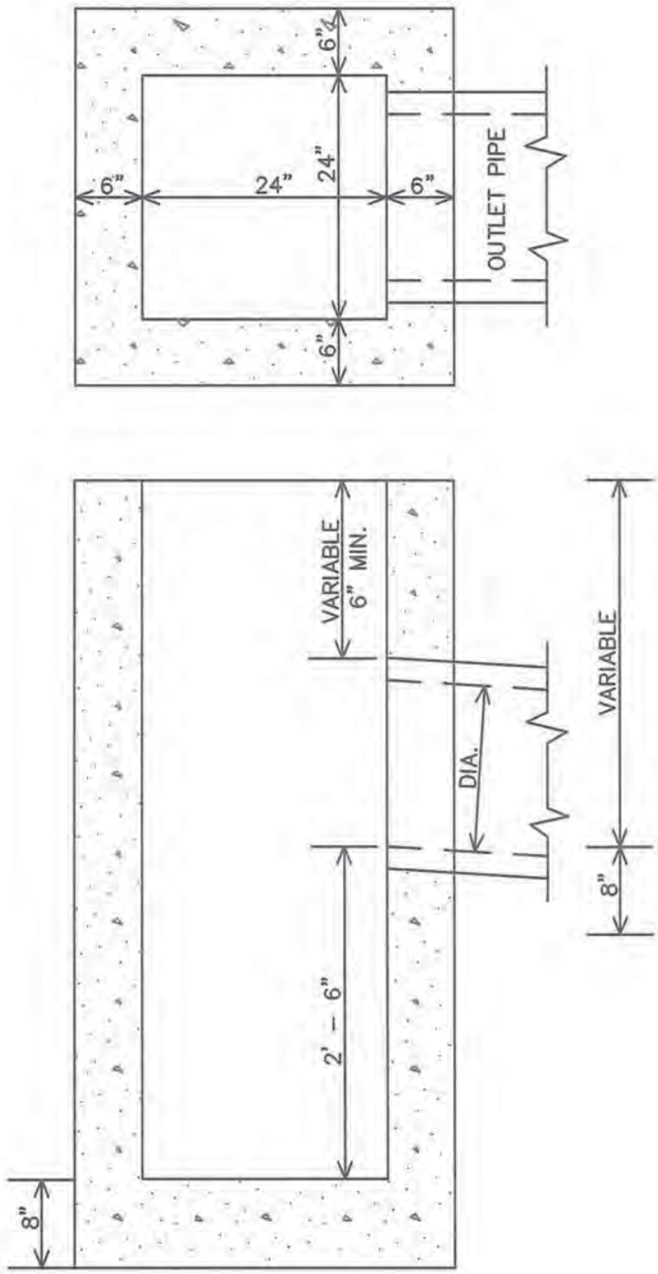
REVISED: ______________________

STANDARD DETAIL

A–CATCHBASIN.DWG



TYPE "A" CATCH BASIN (MODIFIED)
(12" TO 18" PIPES)

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

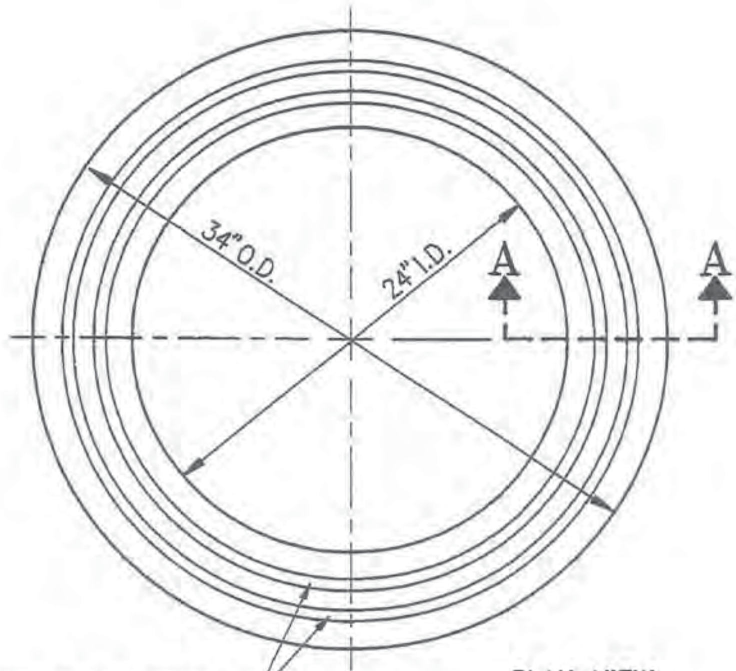
APPROVED: ______ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______

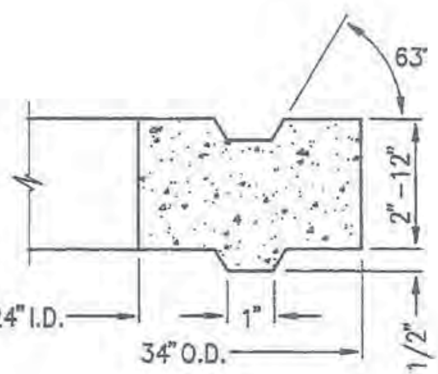
STANDARD DETAIL

A–CATCHBASIN–MODIFIED.DWG



PLAN VIEW

GASKET DETAIL



SECTION "A–A"

PRECAST CONCRETE ADJUSTING RING

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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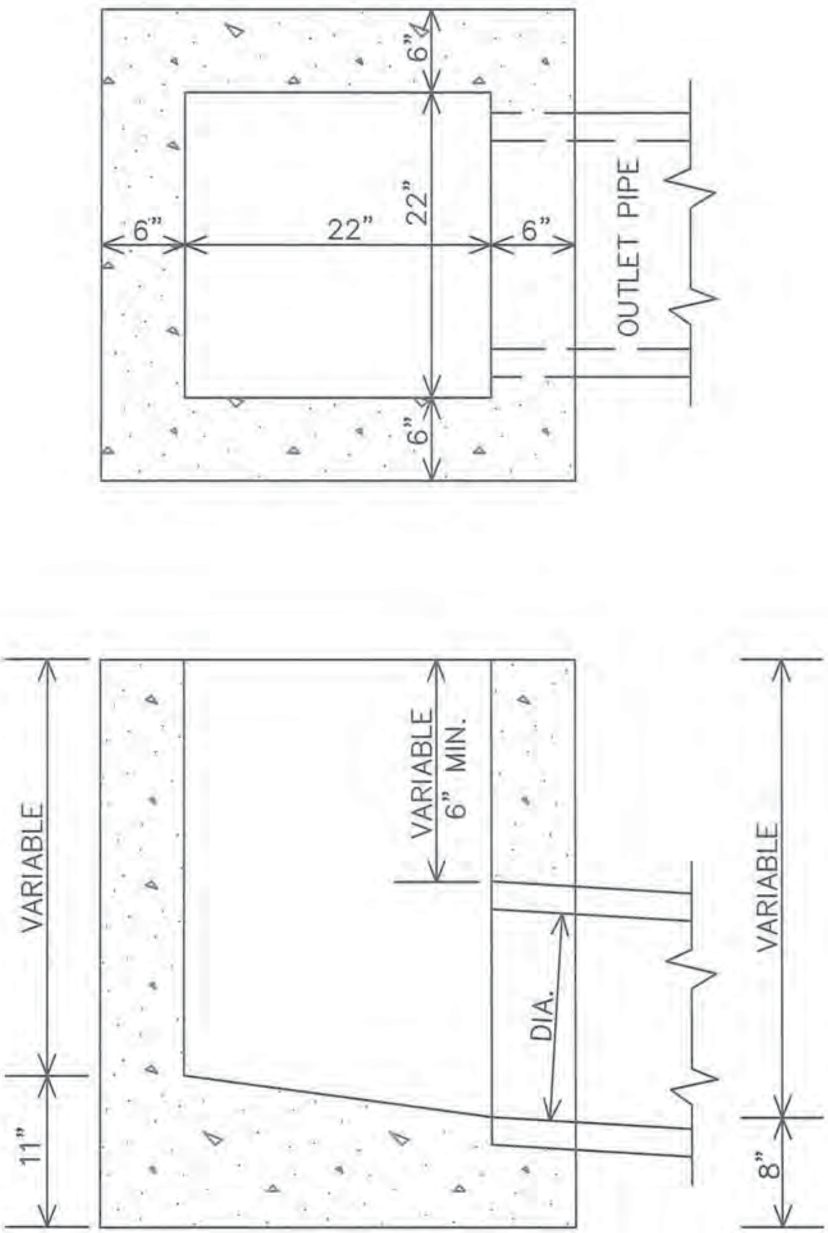
REVISED: ______________________

STANDARD DETAIL

ADJ-RING.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



TYPE "A" INLET
(12" TO 15" PIPES)

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

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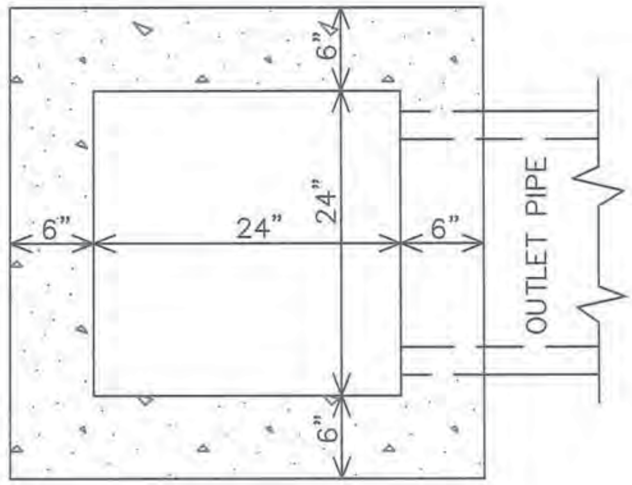
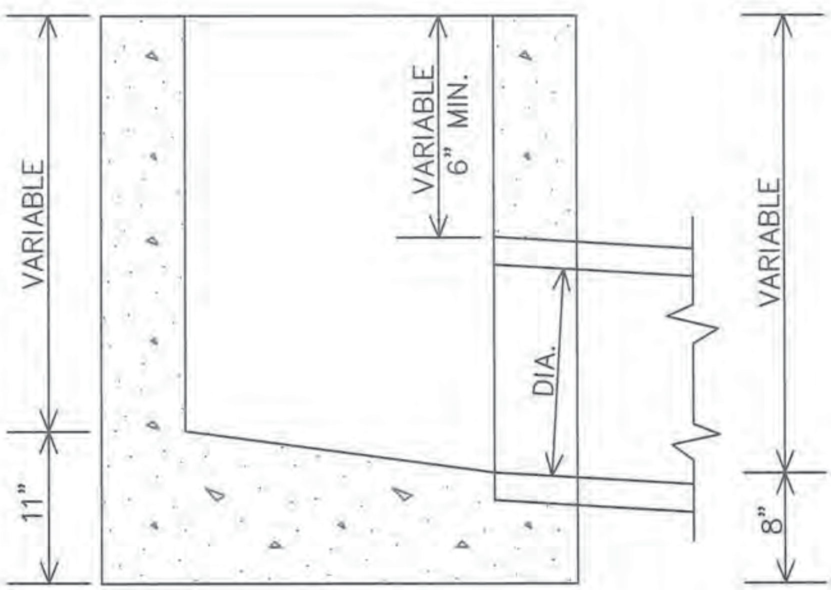
REVISED: ______________________

STANDARD DETAIL

A-INLET.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA





TYPE "A" INLET (MODIFIED)
(12" TO 18" PIPES)

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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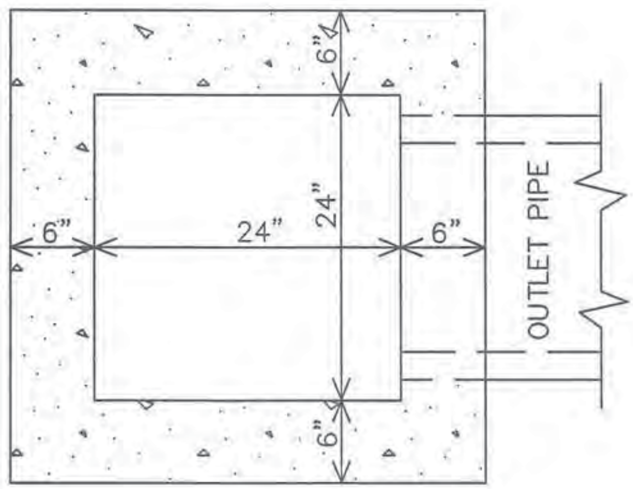
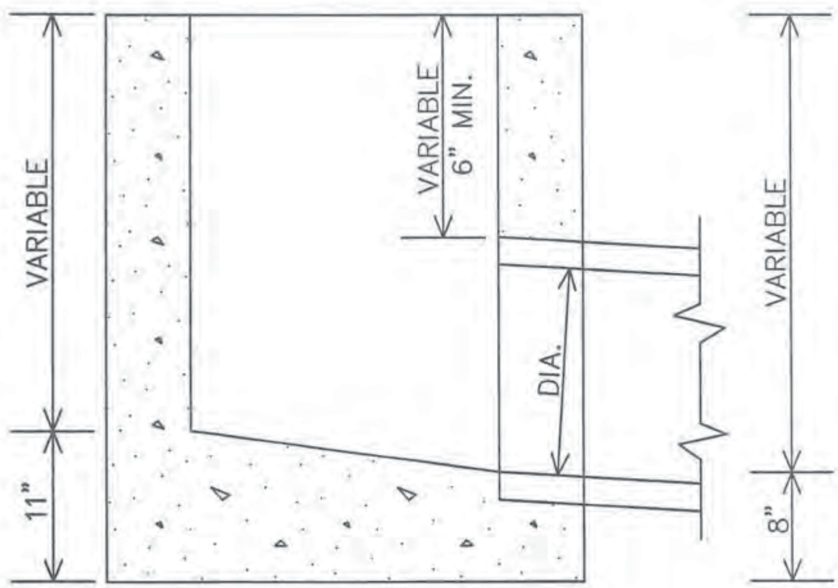
REVISED: ______________

STANDARD DETAIL

A-INLET-MODIFIED.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA





TYPE "A" INLET (MODIFIED)
(12" TO 18" PIPES)

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

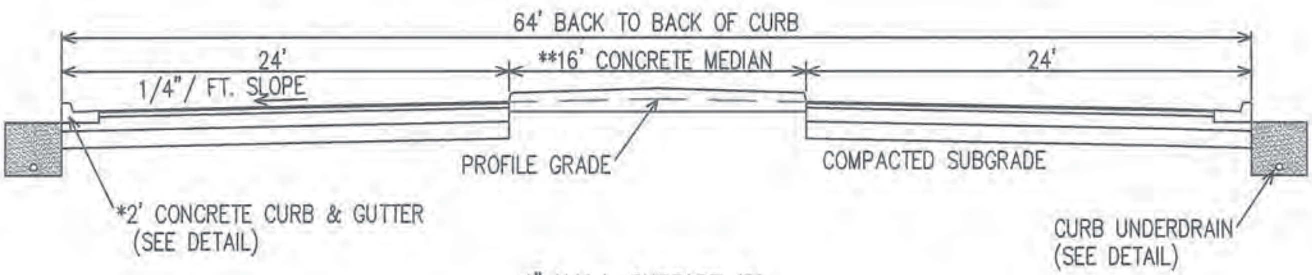
APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______

STANDARD DETAIL

A-INLET-MODIFIED.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



1" H.M.A. SURFACE #11
2.5" H.M.A. INTERMEDIATE #8
9.5" H.M.A. BASE #5
12" LIME STABILIZED BASE

* CONCRETE STANDING CURB AS ALTERNATE.

** SEE DETAIL

ARTERIAL ASPHALT STREET CONCRETE MEDIAN
SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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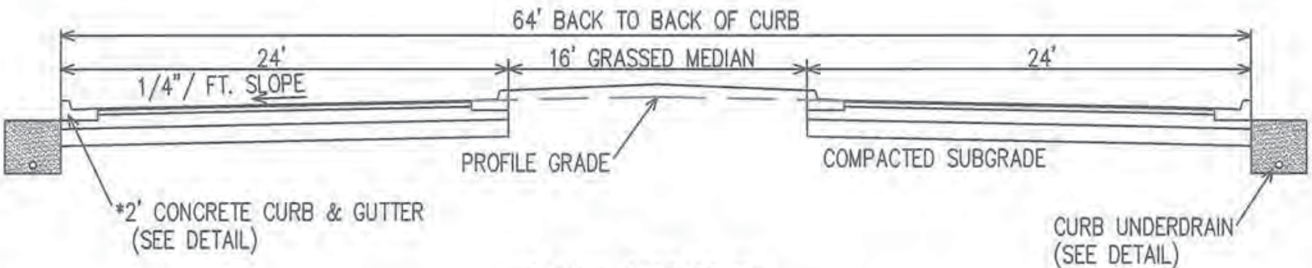
REVISED: ______________

STANDARD DETAIL

ARTERIALASPHALT–CONCRETEMEDIAN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



1" H.M.A. SURFACE #11
2.5" H.M.A. INTERMEDIATE #8
9.5" H.M.A. BASE #5
12" LIME STABILIZED BASE

* CONCRETE STANDING CURB AS ALTERNATE.

ARTERIAL ASPHALT STREET GRASSED MEDIAN SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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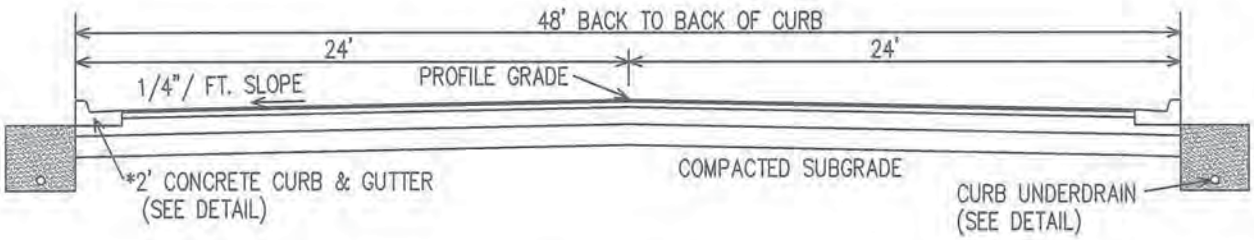
REVISED: ______________

STANDARD DETAIL

ARTERIALASPHALT-GRASSMEDIAN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



1" H.M.A. SURFACE #11
2.5" H.M.A. INTERMEDIATE #8
9.5" H.M.A. BASE #5
12" LIME STABILIZED BASE

* CONCRETE STANDING CURB AS ALTERNATE.

ARTERIAL ASPHALT STREET NO MEDIAN
SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ____________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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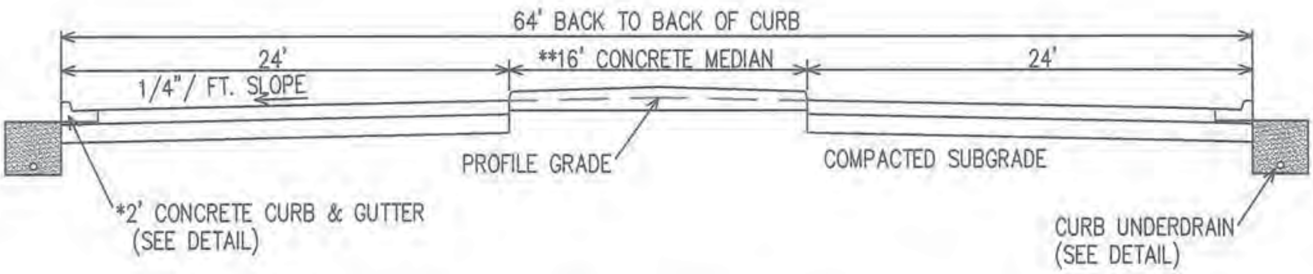
REVISED: ____________________

STANDARD DETAIL

ARTERIALASPHALT–NOMEDIAN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



9" PORTLAND CEMENT CONCRETE
12" LIME STABILIZED BASE

* CONCRETE STANDING CURB AS ALTERNATE.

** SEE DETAIL

ARTERIAL CONCRETE STREET CONCRETE MEDIAN
SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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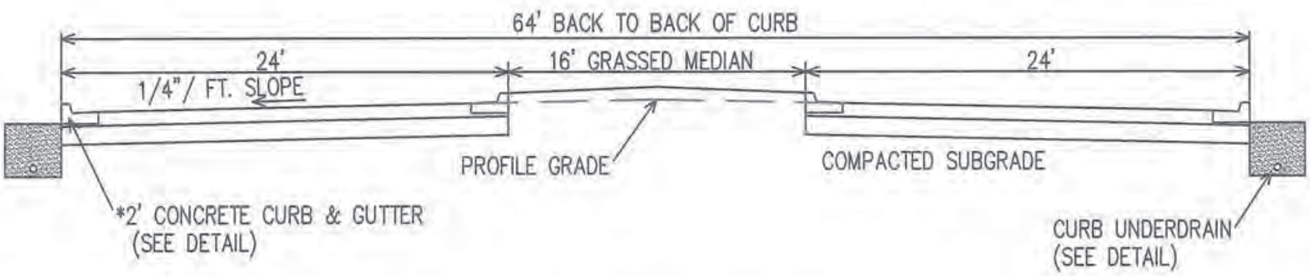
REVISED: ______________

STANDARD DETAIL

ARTERIALCONCRETE–CONCRETEMEDIAN.DWG



9" PORTLAND CEMENT CONCRETE
12" LIME STABILIZED BASE

* CONCRETE STANDING CURB AS ALTERNATE.

ARTERIAL CONCRETE STREET GRASSED MEDIAN SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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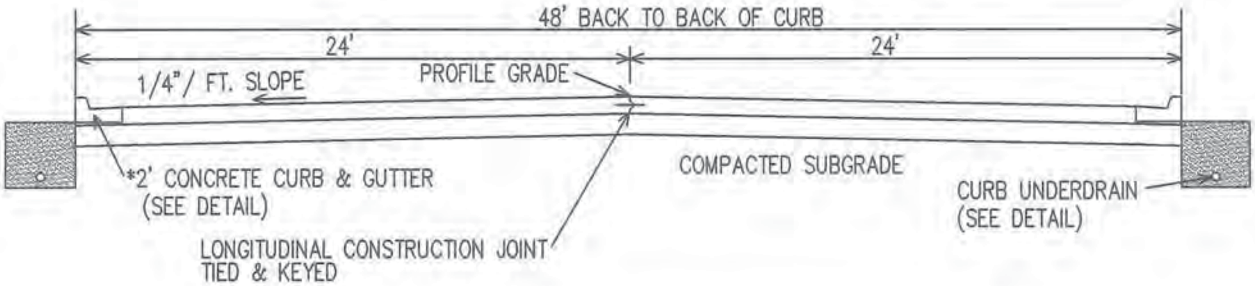
REVISED: ______________________

STANDARD DETAIL

ARTERIALCONCRETE-GRASSMEDIAN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



9" PORTLAND CEMENT CONCRETE
12" LIME STABILIZED BASE

* CONCRETE STANDING CURB AS ALTERNATE.

ARTERIAL CONCRETE STREET NO MEDIAN
SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

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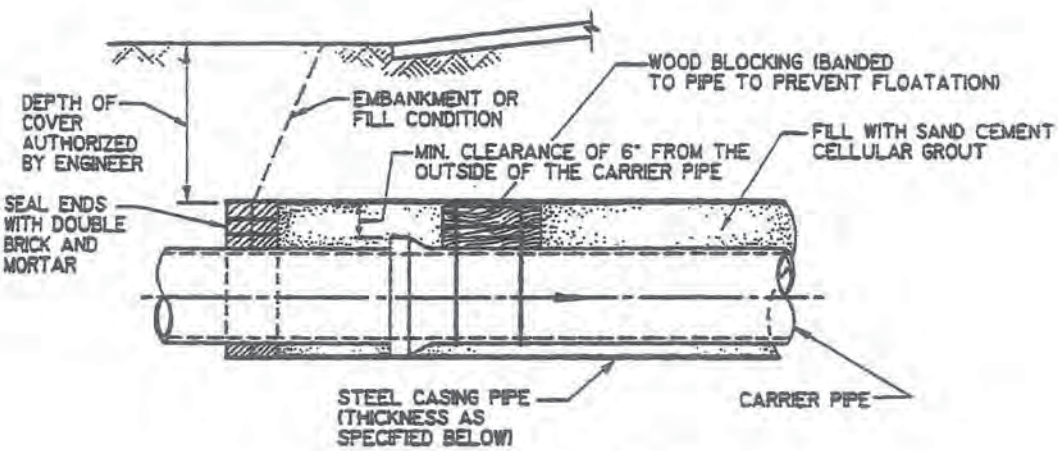
REVISED: ______________________

STANDARD DETAIL

ARTERIALCONCRETE-NOMEDIAN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



NOMINAL WALL THICKNESS

		RAILROAD CROSSINGS		HIGHWAY CROSSINGS	
Nominal Size	Actual O.D.	Bare	Protective Coated	Bare	Protective Coated
8"	8 5/8"	.250	.188	.250	.188
10"	10 3/4	.250	.188	.250	.188
12"	12 3/4"	.250	.188	.250	.188
14"	14"	.281	.219	.250	.219
16"	16"	.281	.219	.250	.219
18"	18"	.312	.250	.250	.250
20"	20"	.344	.281	.312	.250
24"	24"	.406	.344	.312	.250
30"	30"	.469	.406	.375	.375
36"	36"	.532	.469	.500	.438
42"	42"	.563	.500	.500	.500
48"	48"	.625	.563	.625	.563
54"	54"	.688	.625	.625	.625
60"	60"	.750	.688	.625	.625
66"	66"	.813	.750	.625	.625
72"	72"	.875	.813	.750	.750

BORE DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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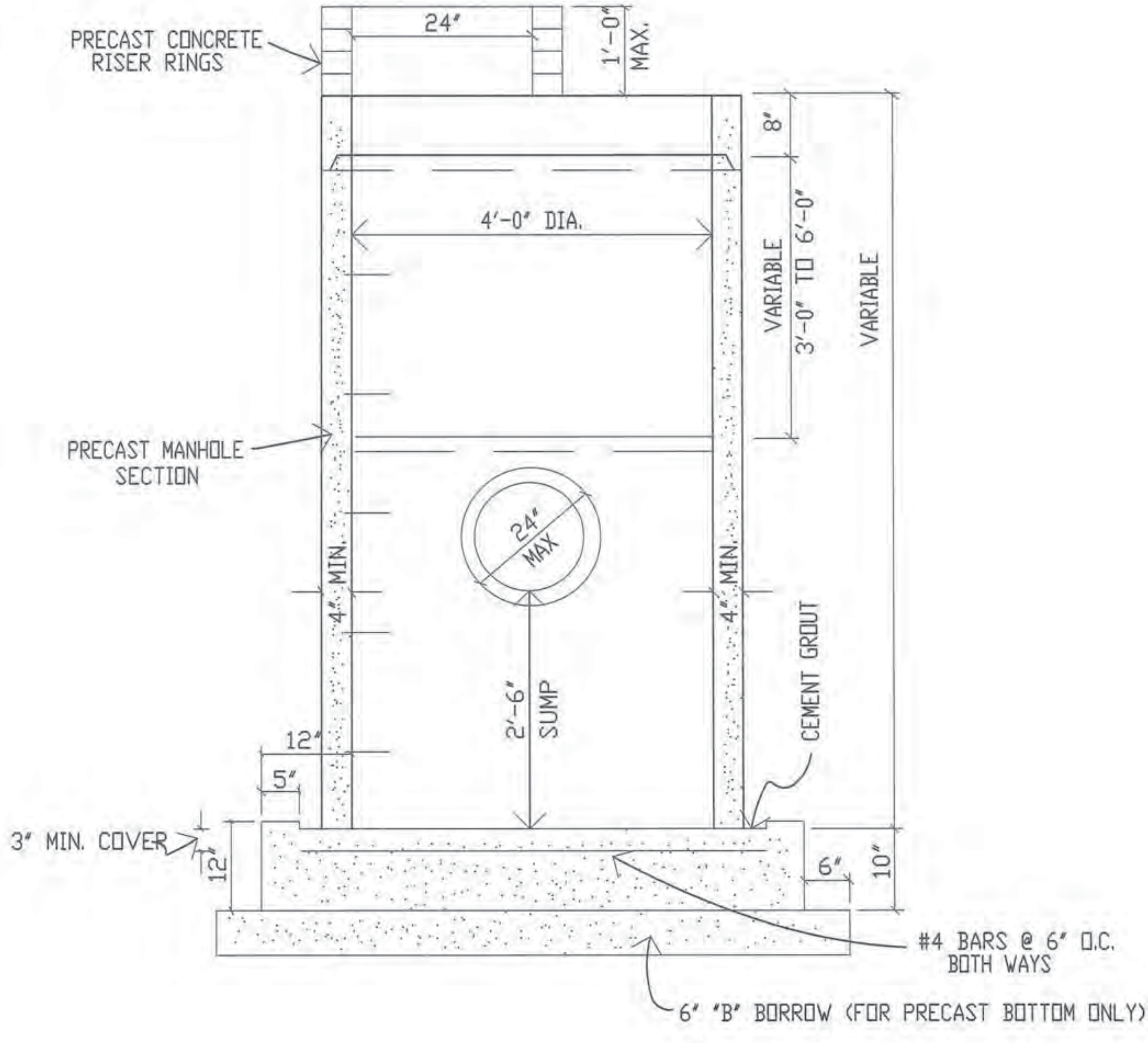
REVISED: ______________________

STANDARD DETAIL

BORE.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



TYPE "C" CATCH BASIN

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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REVISED: ______________

STANDARD DETAIL

C-CATCHBASIN.DWG

Rock Check Dam

Requirements

Contributing drainage area: 2 acres maximum.

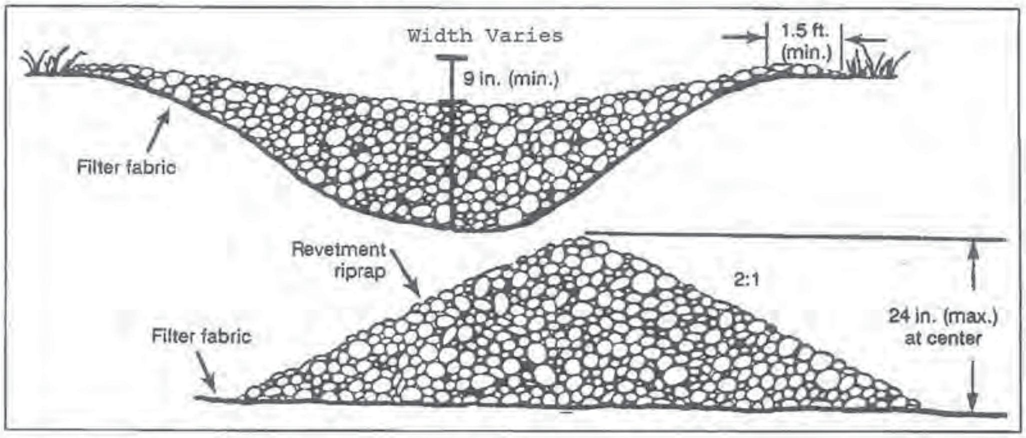
Dam center: 2 ft. maximum height but at least 9 in. lower than the outer edges at natural ground elevation.

Dam side slope: 2:1 or flatter.

Distance between dams: Spaced so the toe of the upstream dam is the same elevation as the top of the downstream dam.

Overflow areas along channel: Stabilized to resist erosion.

Rock size: INDOT Revetment Riprap.



Forward and cross-section views of a rock check dam.

ROCK CHECK DAM

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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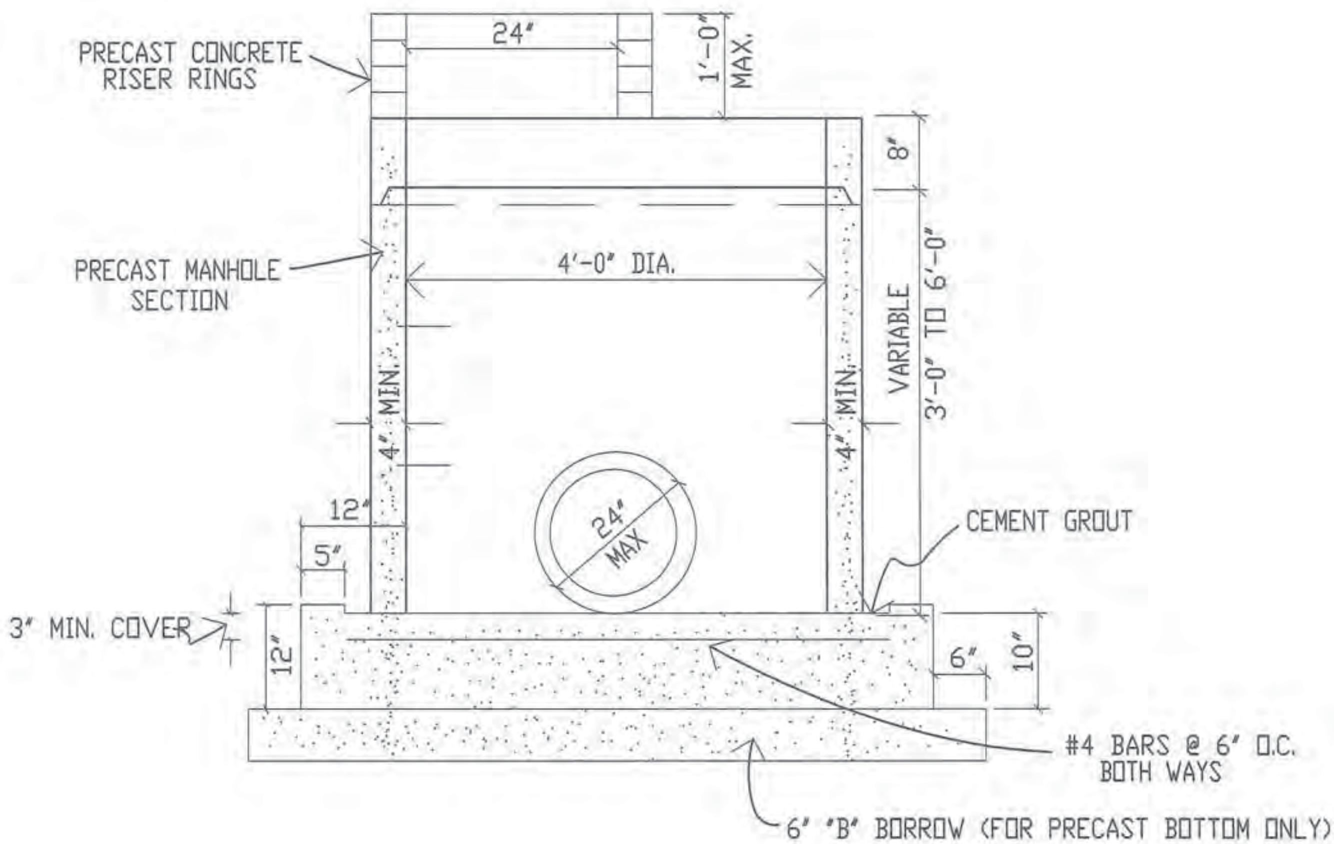
REVISED: ______________

STANDARD DETAIL

CHECKDAM.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



TYPE "C" INLET

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

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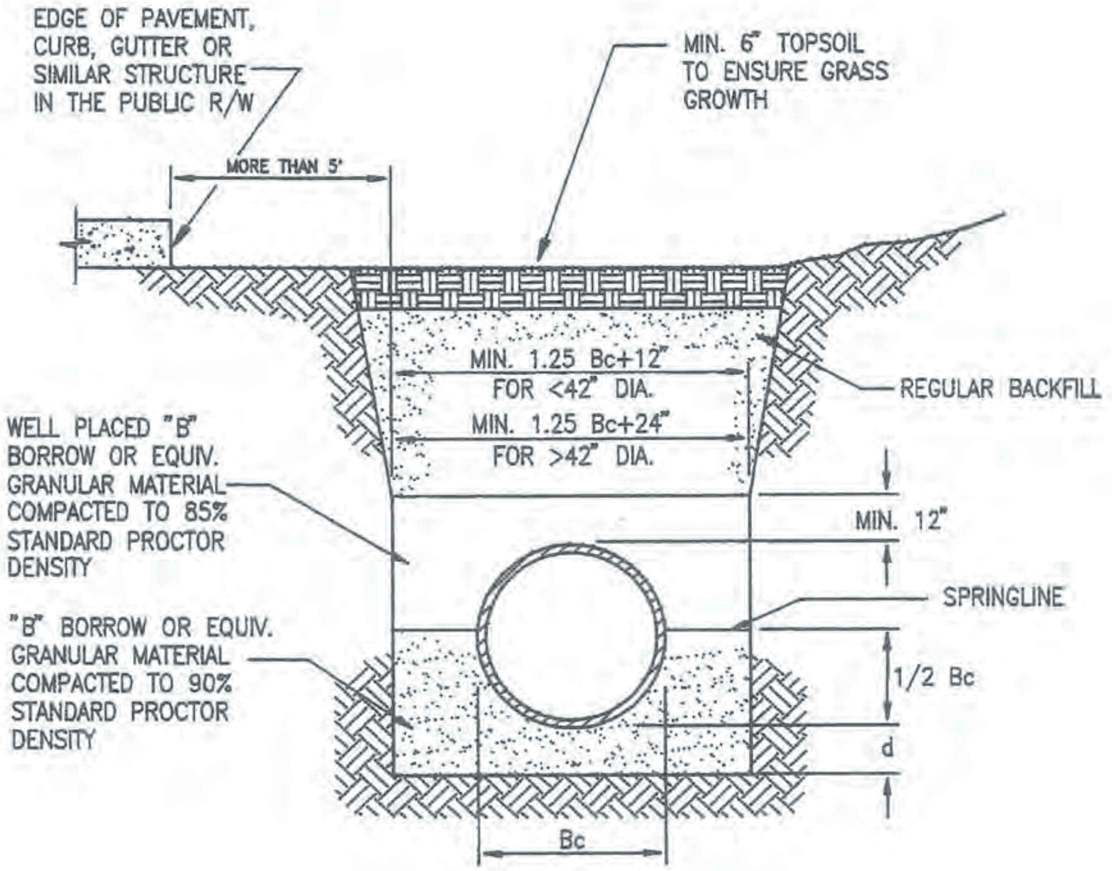
REVISED: ______________

STANDARD DETAIL

C-INLET.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



GREATER THAN 5' FROM EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" CLEARANCE EACH SIDE OF PIPE FOR 42" DIA. AND LESS

MIN. 12" CLEARANCE EACH SIDE OF PIPE FOR LARGER THAN 42" DIA.

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

CORRUGATED METAL PIPE TRENCH DETAIL
OUTSIDE 5 FEET OF PAVEMENT

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

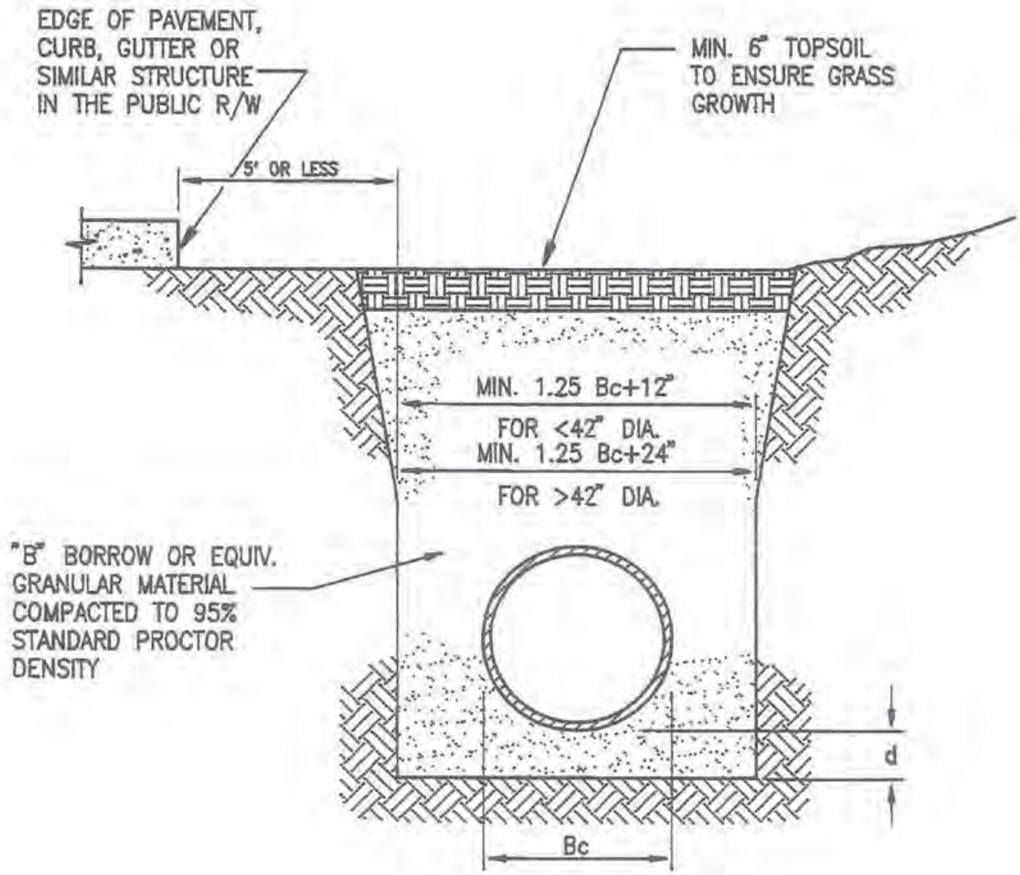
APPROVED: ______________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______________

STANDARD DETAIL

CMPTRENCH1.DWG



WITHIN 5' OF EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" CLEARANCE EACH SIDE OF PIPE FOR 42" DIA. AND LESS

MIN. 12" CLEARANCE EACH SIDE OF PIPE FOR LARGER THAN 42" DIA.

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

CORRUGATED METAL PIPE TRENCH DETAIL WITHIN 5 FEET OF PAVEMENT

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

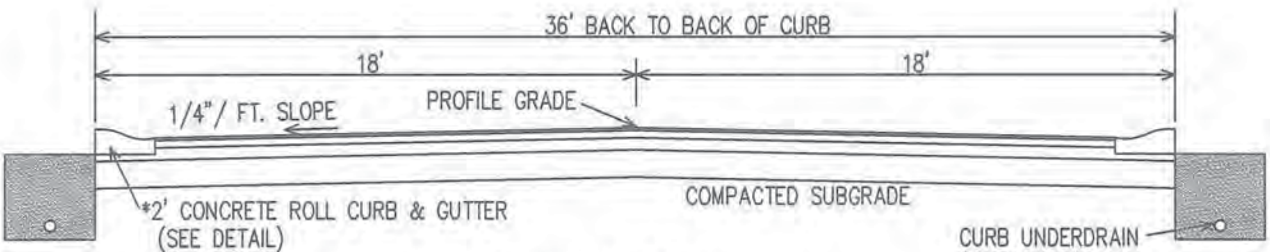
APPROVED: ______________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______________

STANDARD DETAIL

CMPTRENCH2.DWG



1" H.M.A. SURFACE #11
2.5" H.M.A. INTERMEDIATE #8
5.5" H.M.A. BASE #5
12" LIME STABILIZED BASE

* FOR INDUSTRIAL AND COMMERCIAL STREETS, USE 2' CONCRETE CURB & GUTTER OR CONCRETE STANDING CURB.

COLLECTOR ASPHALT STREET SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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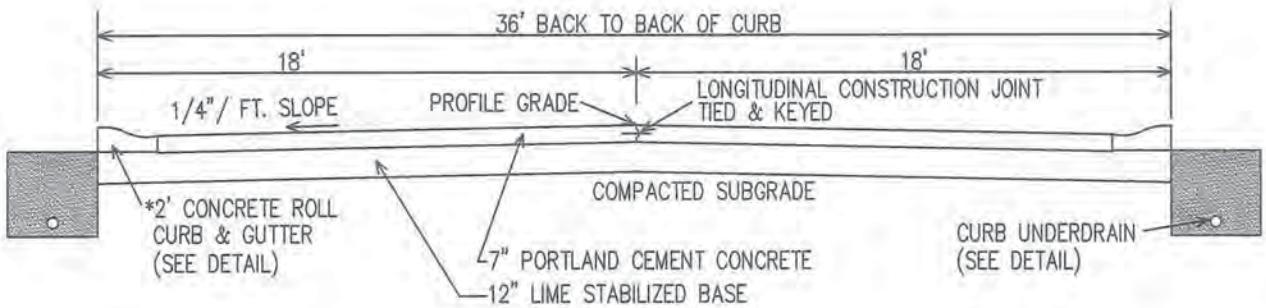
REVISED: ______________________

STANDARD DETAIL

COLLECTORASPHALTSTREET.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



* FOR NON-RESIDENTIAL STREETS, USE 2' CONCRETE CURB & GUTTER OR CONCRETE STANDING CURB.

COLLECTOR CONCRETE STREET SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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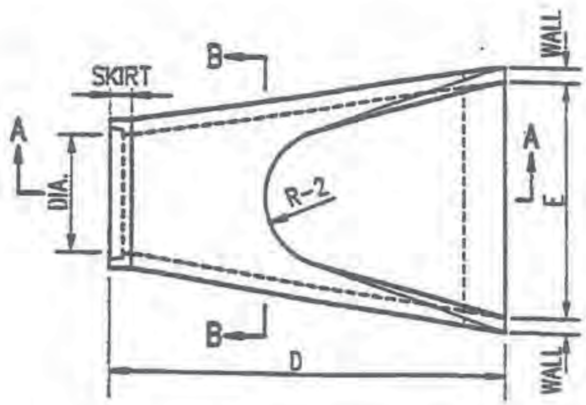
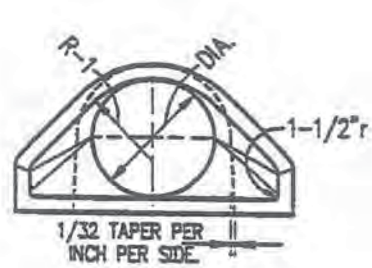
REVISED: ______________

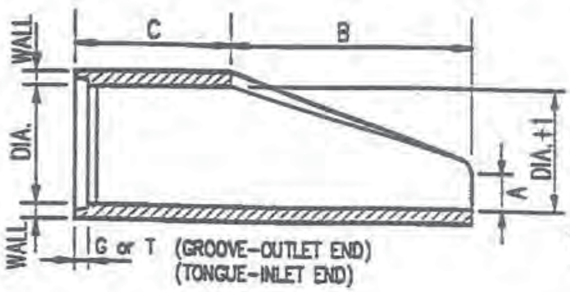
STANDARD DETAIL

COLLECTORCONCRETESTREET.DWG

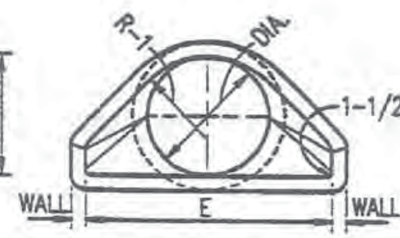




HORIZONTAL FLARE



SECTION AA



VERTICAL FLARE
SECTION BB

DIA.	WALL	G or T	WT. SEC	A	B	C	D	E	DIA.+1	R-1	R-2	SKIRT
12	2	1 1/2	530	4	24	48 7/8	72 7/8	24	13	10 1/16	9	3 1/2
15	2 1/4	2	740	6	27	46	73	30	16	12 1/2	11	3 1/2
18	2 1/2	2 1/2	990	9	27	46	73	36	19	15 1/2	12	4
21	2 3/4	2 1/4	1280	9	35	38	73	42	22	16 1/8	13	4
24	3	2 1/2	1520	9 1/2	43 1/2	30	73 1/2	48	25	16 11/16	14	4 1/2
27	3 1/4	2 1/2	1930	10 1/2	48	25 1/2	73 1/2	54	28	17 3/4	14 1/2	4 1/2
30	3 1/2	3	2190	12	54	19 3/4	73 3/4	60	31	18 5/16	15	5
33	3 3/4	3 3/8	3150	13 1/2	58 1/2	39 1/4	97 3/4	66	34	23 3/4	17 1/2	5 1/2
36	4	3 1/2	4100	15	63	34 3/4	97 3/4	72	37	24 1/16	20	5 1/2
42	4 1/2	3 3/4	5380	21	63	35	98	78	43	27 1/4	22	5 1/2
48	5	4 1/4	6550	24	72	26	98	84	49	28 1/8	22	5 3/4
54	5 1/2	4 3/4	8040	27	65	35	100	90	55	32 7/8	24	6 1/4
60	6	5	8750	30	60	39	99	96	61	36 3/4	24	6 3/4
66	6 1/2	5 1/2	10630	24	78	21	99	102	67	35 11/16	24	7 1/4
72	7	6	12520	34	78	21	99	108	73	38 5/8	24	7 3/4
78	7 1/2	6 1/2	14430	24	78	21	99	114	79	41 15/16	24	8 1/2
84	8	7	16350	24	78	21	99	120	85	44 13/16	24	9

NOTES: 1. MANUFACTURE OF END SECTION IS IN ACCORDANCE WITH APPLICABLE PORTIONS OF A.S.T.M. SPECIFICATION C76.

CONCRETE END SECTION

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

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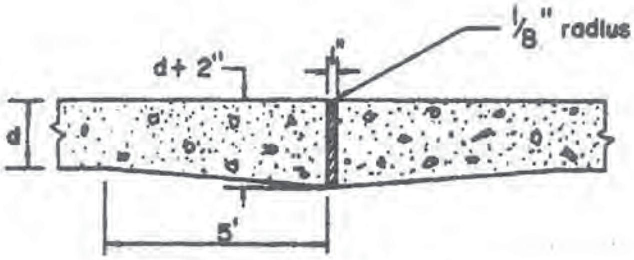
REVISED: ______________________

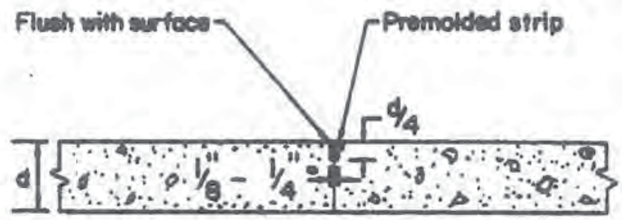
STANDARD DETAIL

CONCRETEENDSECTION.DWG

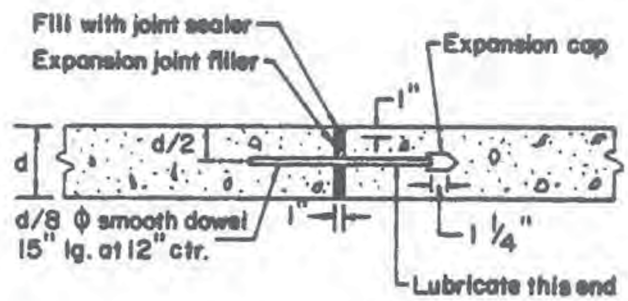
STANDARD DETAIL – MADISON COUNTY, INDIANA



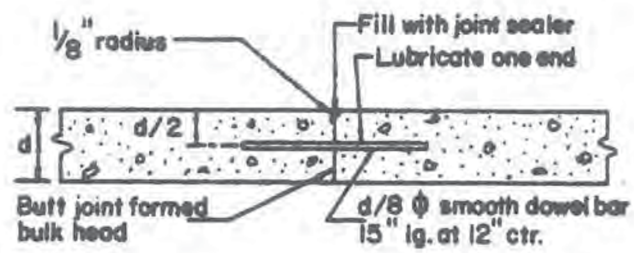
TYPE A
EXPANSION JOINT



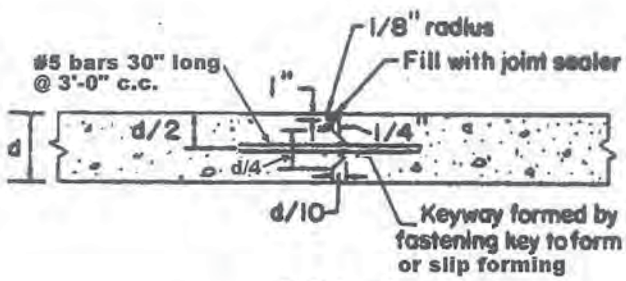
TYPE C
SAWED OR PREMOLDED STRIP
Longitudinal or Transverse



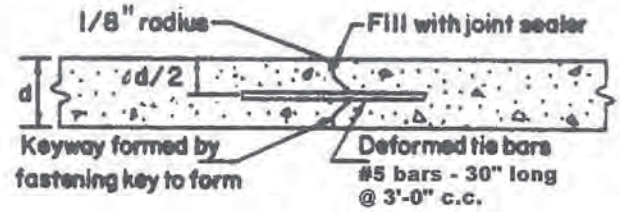
TYPE A-ALTERNATE
EXPANSION JOINT



TYPE D
TRANSVERSE CONSTRUCTION JOINT



TYPE B
LONGITUDINAL CONSTRUCTION JOINT
TIED & KEYED



TYPE E
TIED TRANSVERSE CONSTRUCTION JOINT

CONCRETE PAVEMENT JOINT DETAILS

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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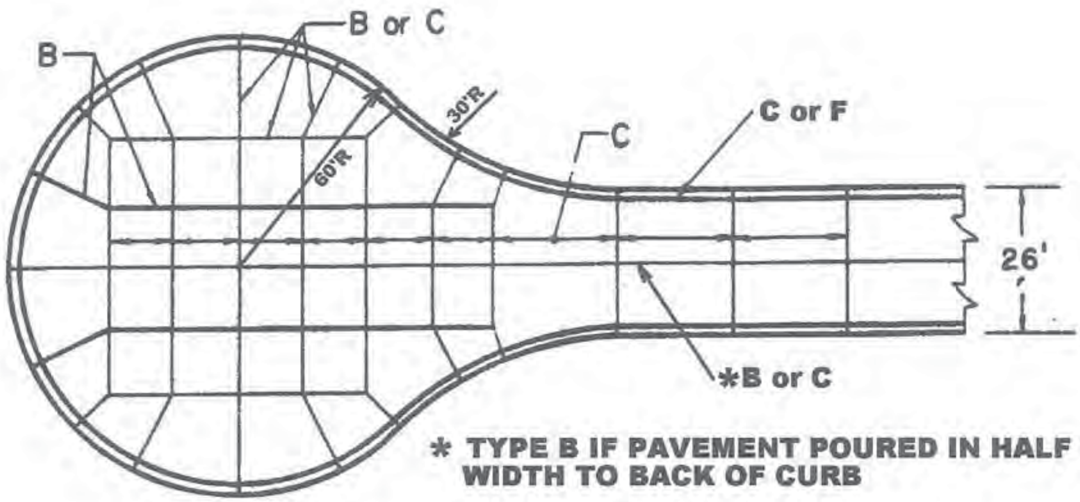
REVISED: ______________________

STANDARD DETAIL

CONCRETEJOINTS.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



* TYPE B IF PAVEMENT POURED IN HALF WIDTH TO BACK OF CURB

CUL-DE-SAC
FULLY PAVED

CONCRETE CUL-DE-SAC JOINTS

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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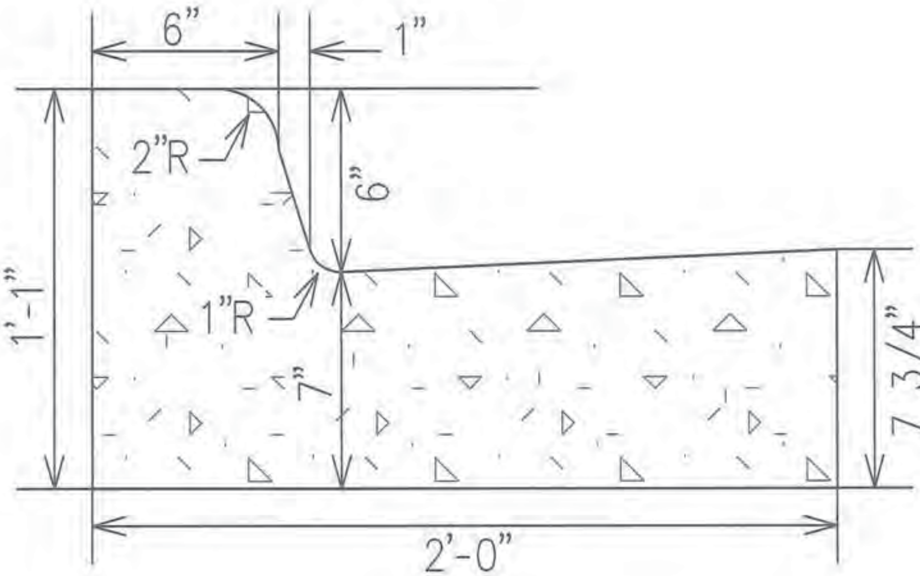
REVISED: ______________

STANDARD DETAIL

CULDESACJOINTS.DWG



2 FOOT CONCRETE CURB & GUTTER

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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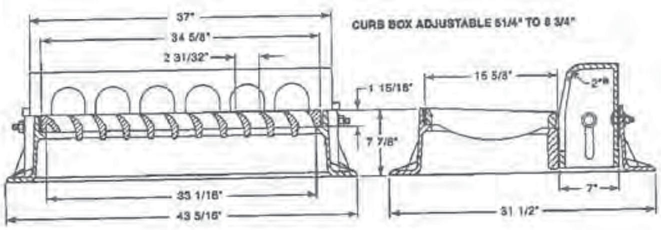
REVISED: ______________

STANDARD DETAIL

CURB&GUTTER.DWG

R-3287-10V
Curb Inlet Frame, Grate, Curb Box

Heavy Duty



NEENAH OR EQUAL

2 FOOT CONCRETE CURB
AND GUTTER INLET CASTING
FOR TYPE "J" BOXES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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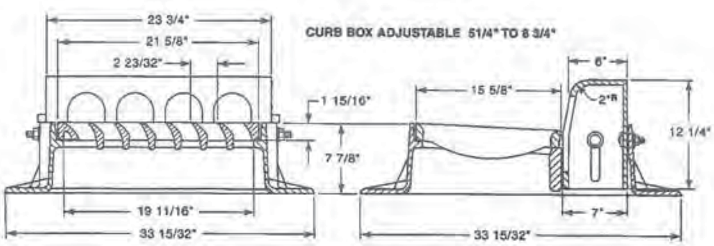
REVISED: ______________________

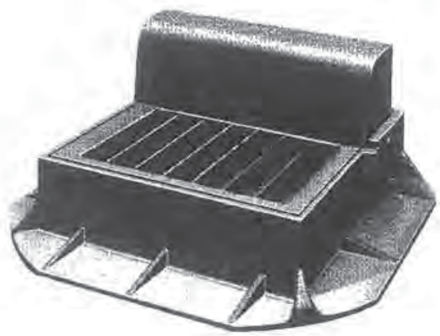
STANDARD DETAIL

CURBINLET-CASTING.DWG

R-3286-8V
Curb Inlet Frame, Grate, Curb Box

Heavy Duty





NEENAH OR EQUAL

2 FOOT CONCRETE CURB
AND GUTTER INLET CASTING
FOR TYPE "A" BOXES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

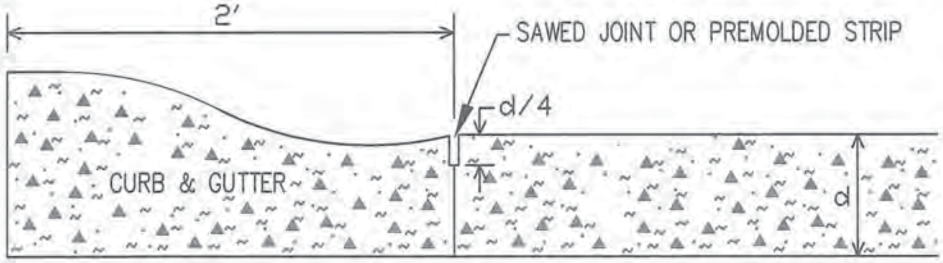
APPROVED: ____________ ______
MADISON COUNTY ENGINEER DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______
DATE

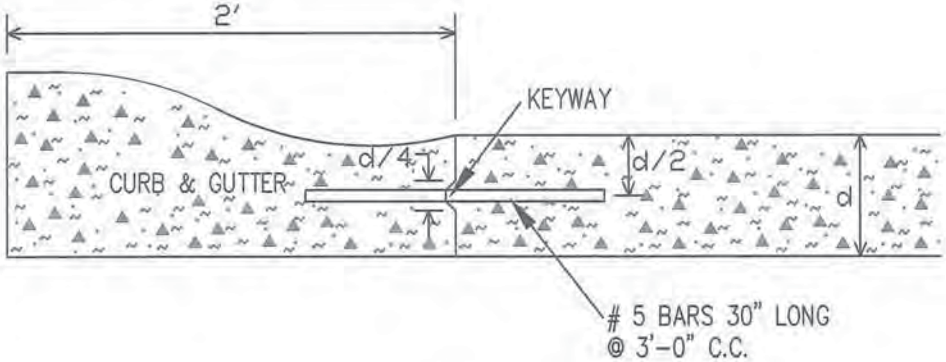
REVISED: ____________

STANDARD DETAIL

CURBINLET-CASTING2.DWG



TYPE "C"
SAWED OR PREMOLDED STRIP
LONGITUDINAL



TYPE "F"
LONGITUDINAL CURB CONSTRUCTION JOINT
TIED & KEYED

CONCRETE CURB JOINT DETAILS

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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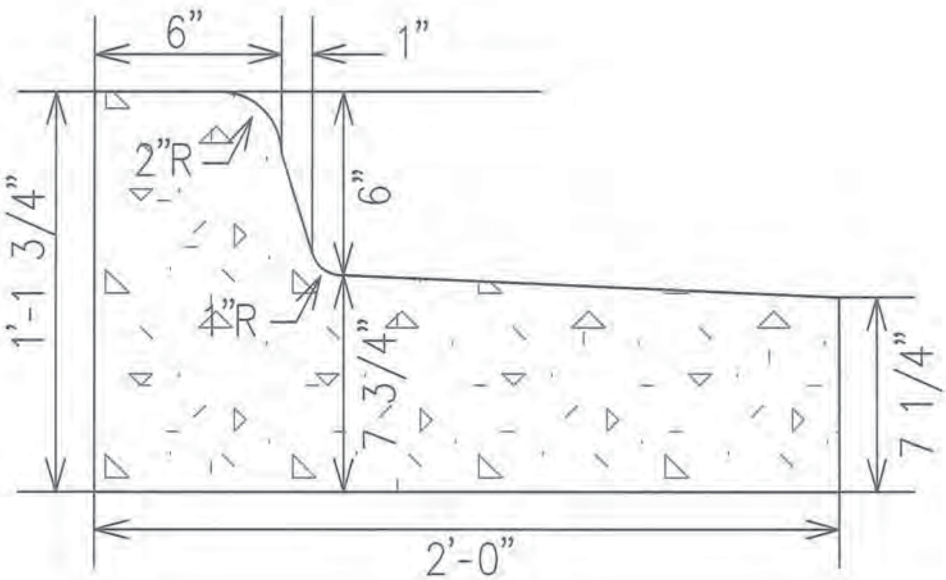
REVISED: ______________

STANDARD DETAIL

CURBJOINTS.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



2 FOOT CONCRETE REVERSED SLOPE CURB & GUTTER

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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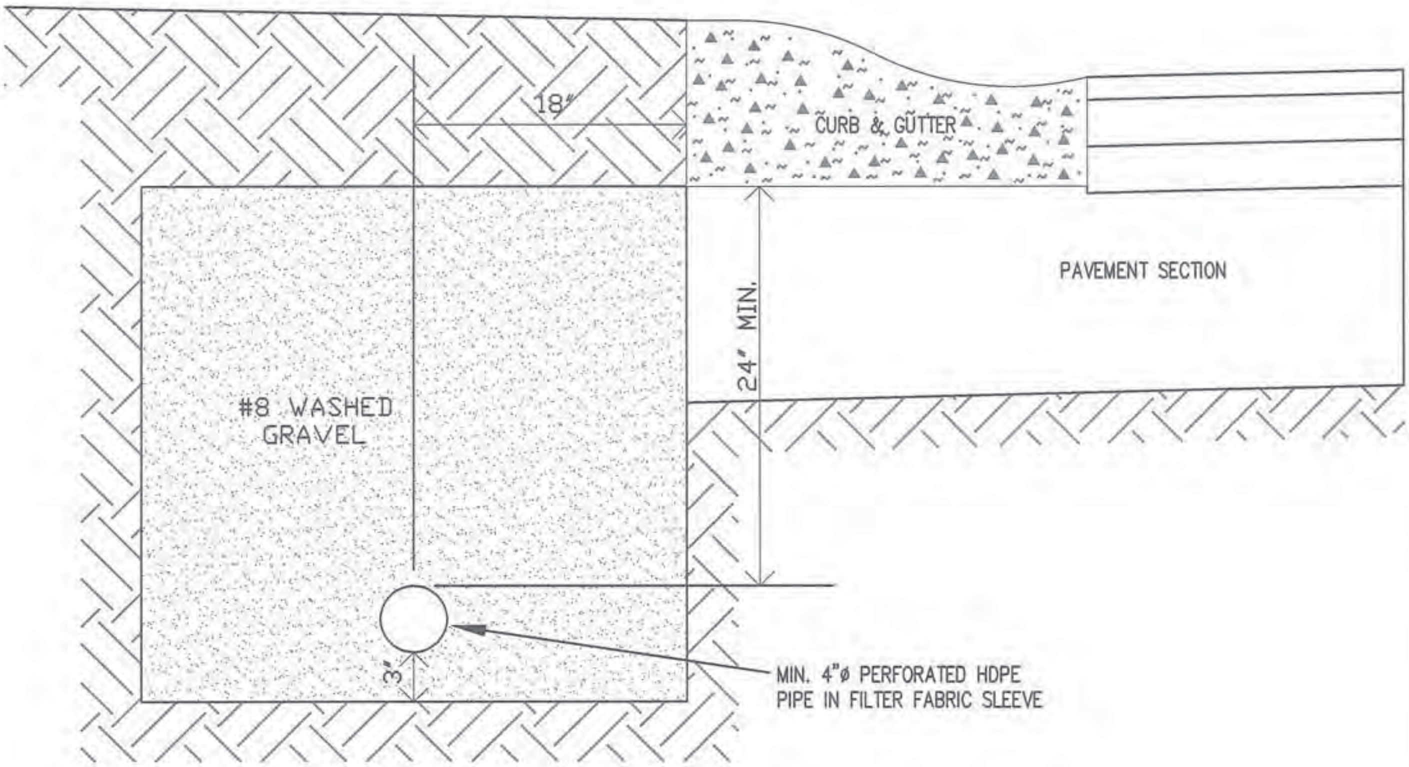
REVISED: ______________________

STANDARD DETAIL

CURB–REVERSE.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



CURB UNDERDRAIN

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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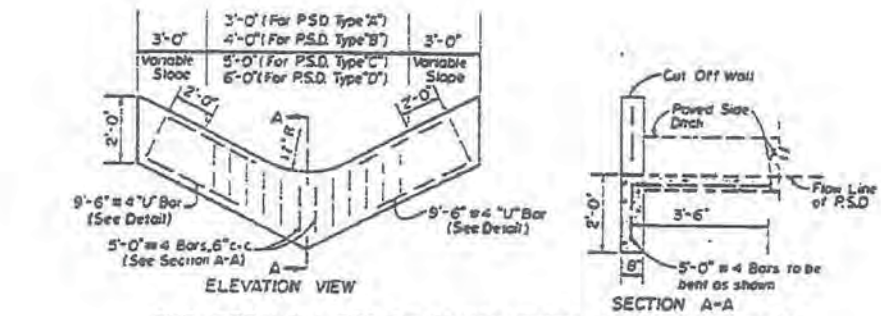
REVISED: ______________________

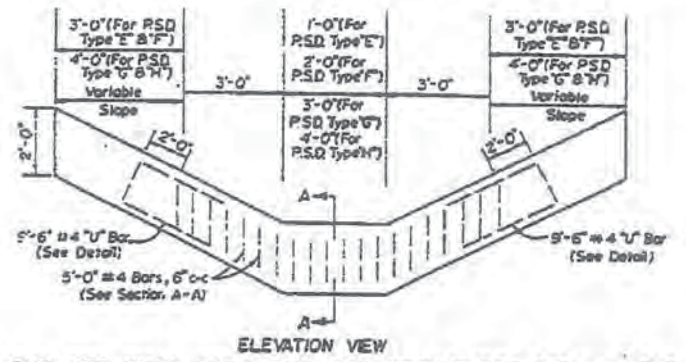
STANDARD DETAIL

CURBUNDERDRAIN.DWG

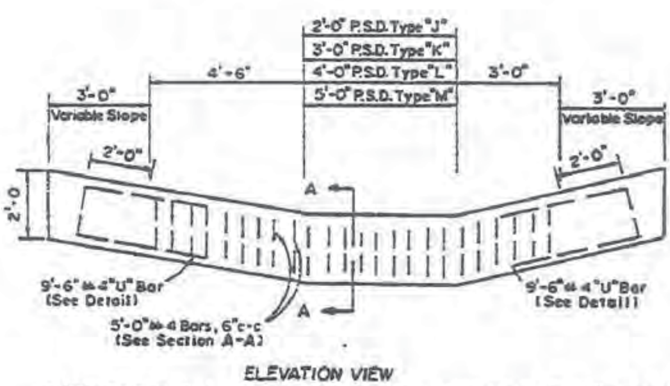
STANDARD DETAIL – MADISON COUNTY, INDIANA



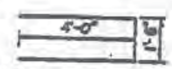
CUT-OFF-WALL FOR PAVED SIDE DITCH TYPES "A" THRU "D"



CUT-OFF-WALL FOR PAVED SIDE DITCH TYPES "E" THRU "H"



CUT-OFF-WALL FOR PAVED SIDE DITCH TYPES "J" THRU "M"



"U" BAR DETAIL

PAVED SIDE DITCH LUG

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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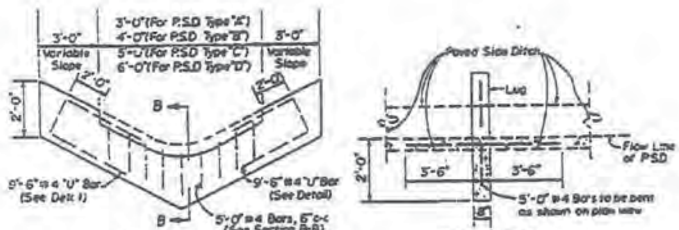
STANDARD DETAIL

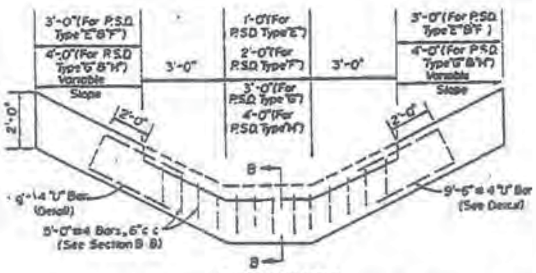
CUTOFFWALL.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



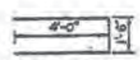
ELEVATION VIEW SECTION B-B

LUG FOR PAVED SIDE DITCH TYPES "A" THRU "D"

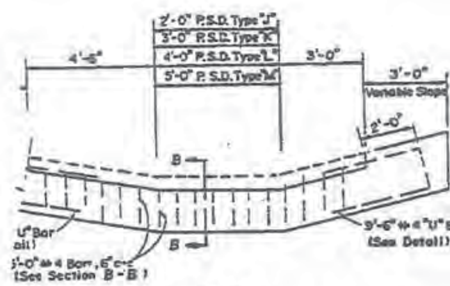


ELEVATION VIEW

LUG FOR PAVED SIDE DITCH TYPES "E" THRU "H"

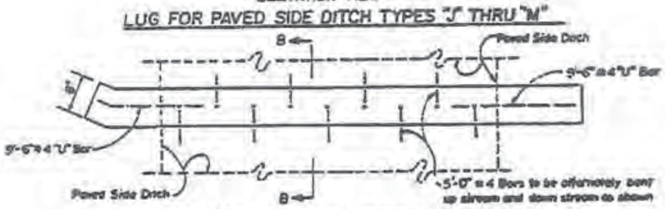


"U" BAR DETAIL



ELEVATION VIEW

LUG FOR PAVED SIDE DITCH TYPES "J" THRU "M"



PLAN VIEW OF LUGS (TYPICAL FOR ALL TYPES)

PAVED SIDE DITCH LUG

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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REVISED: ______

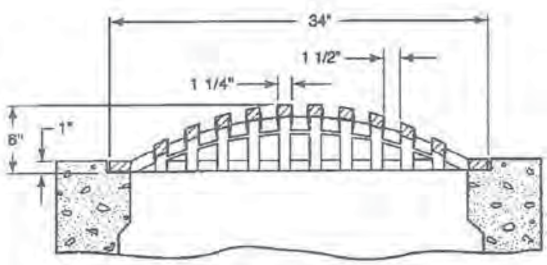
STANDARD DETAIL

DITCHLUG.DWG

R-4215-C
Convex Grate

Heavy Duty

For side ditch drainage.



NEENAH OR EQUAL

CASTING FOR TYPE "E" BOXES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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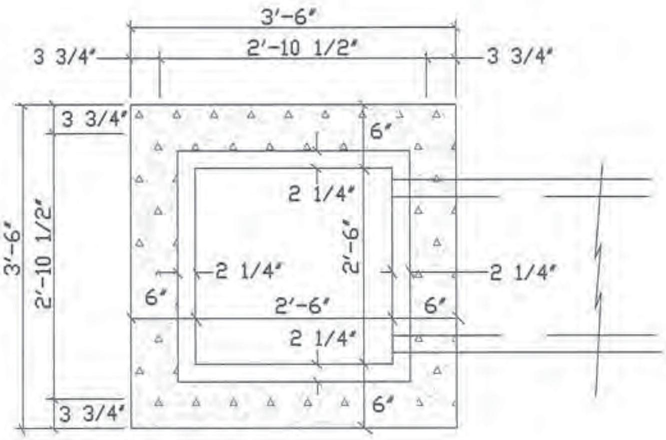
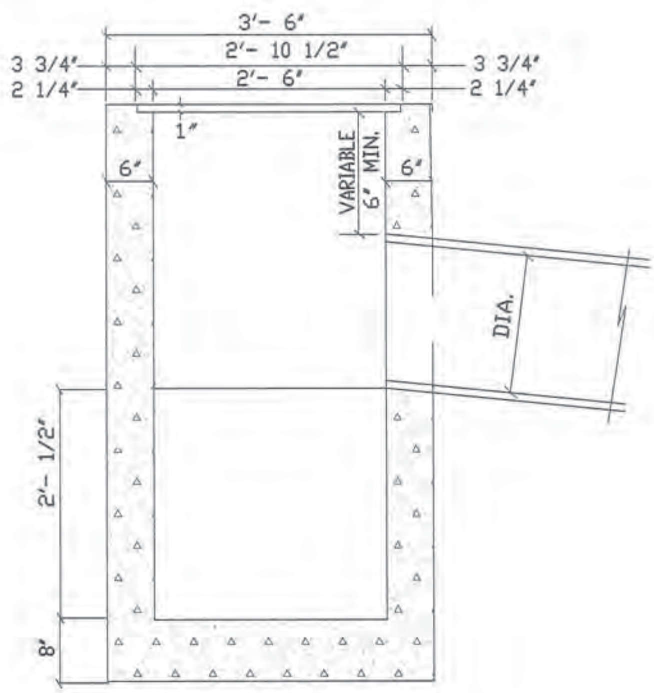
STANDARD DETAIL

E–CASTING.DWG





TYPE "E" CATCH BASIN

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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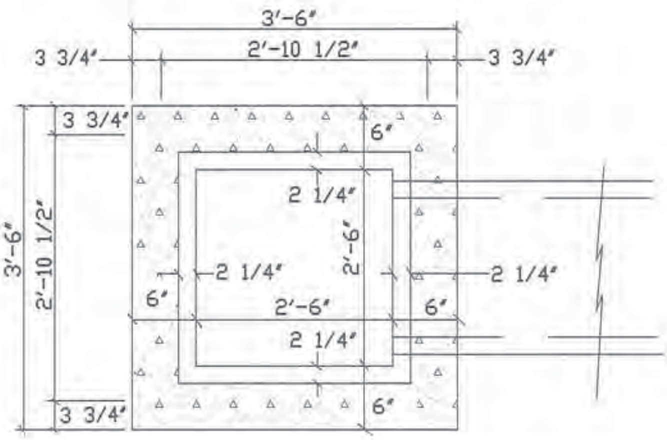
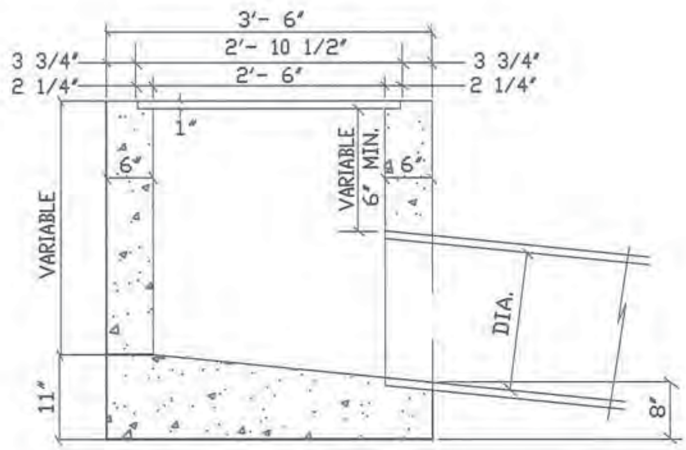
STANDARD DETAIL

ECATCHBASIN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA





TYPE "E" INLET

DRAWING NOT TO SCALE

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APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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REVISED: ______________

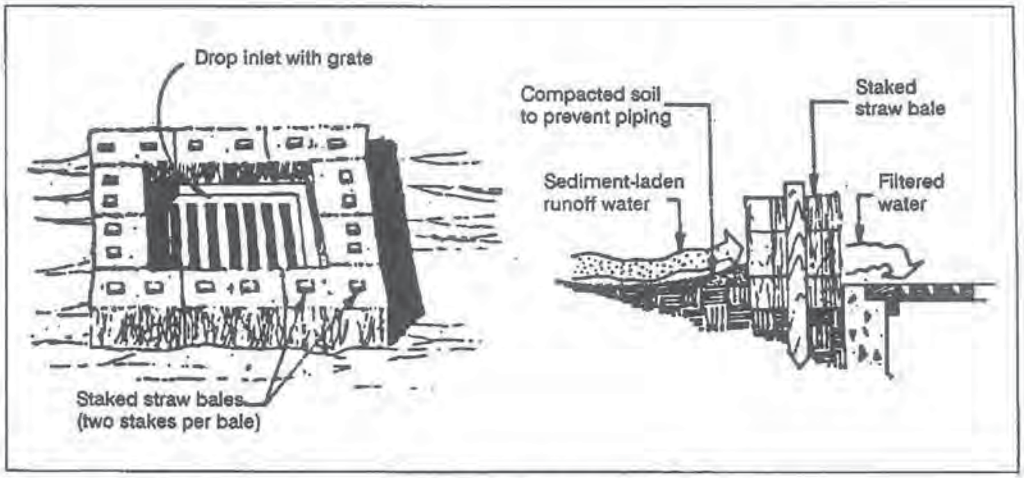
STANDARD DETAIL

E–INLET.DWG

Straw Bale Drop Inlet Protection

Requirements

Contributing drainage area: 1 acre maximum.
Effective life: Less than 3 months.
Capacity: Runoff from a 2-yr. frequency, 24-hr. duration storm event entering a storm drain without by-pass flow.
Approach: Pool area flat (less than 1% slope), with sediment storage of 945 cu.ft./acre disturbed.
Bale dimensions: Approximately 14 in. x 18 in. x 36 in.
Height of bales above inlet: 14 in. (i.e., 18-in. high bales entrenched 4 in.).
Anchoring: Two 36-in. long (minimum) steel rebars or 2 x 2-in. hardwood stakes driven through each bale.



Oblique view of a properly installed straw bale drop inlet protection.

STRAW BALE DROP INLET PROTECTION

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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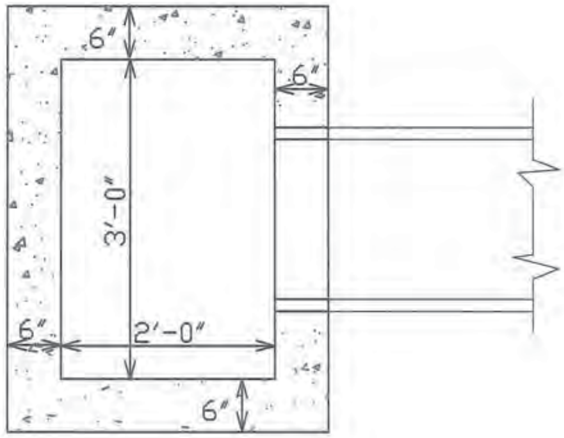
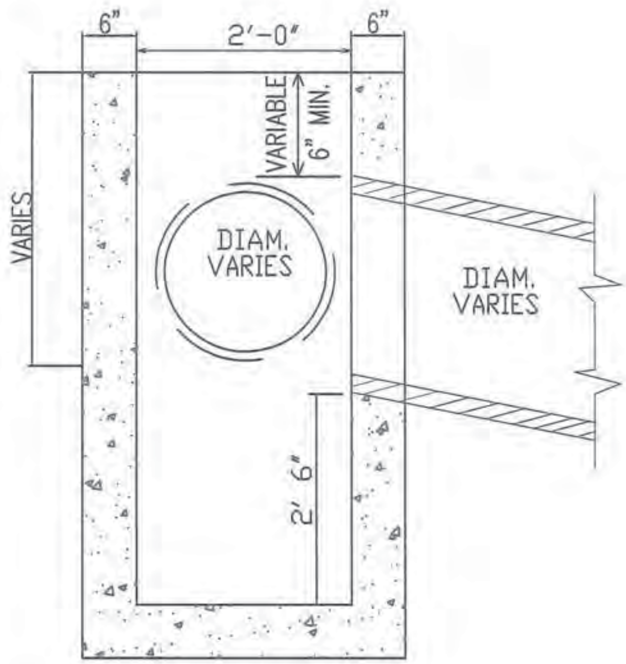
STANDARD DETAIL

INLETBALE.DWG





TYPE "J" CATCH BASIN

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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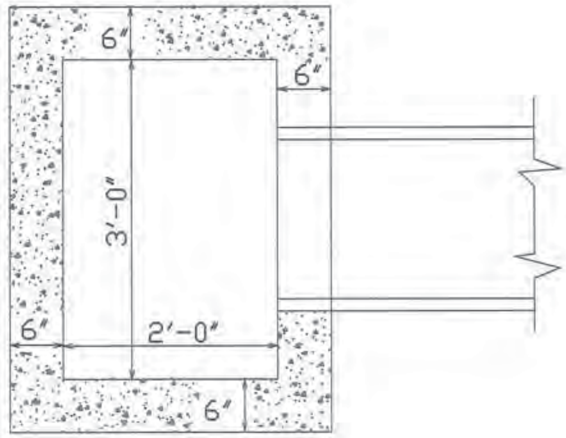
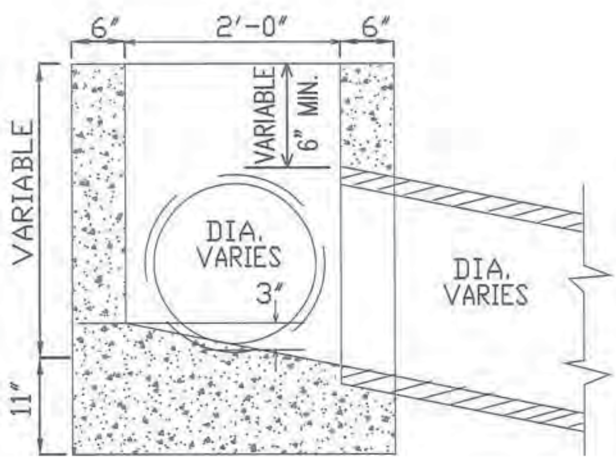
STANDARD DETAIL

J-CATCHBASIN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA





TYPE "J" INLET

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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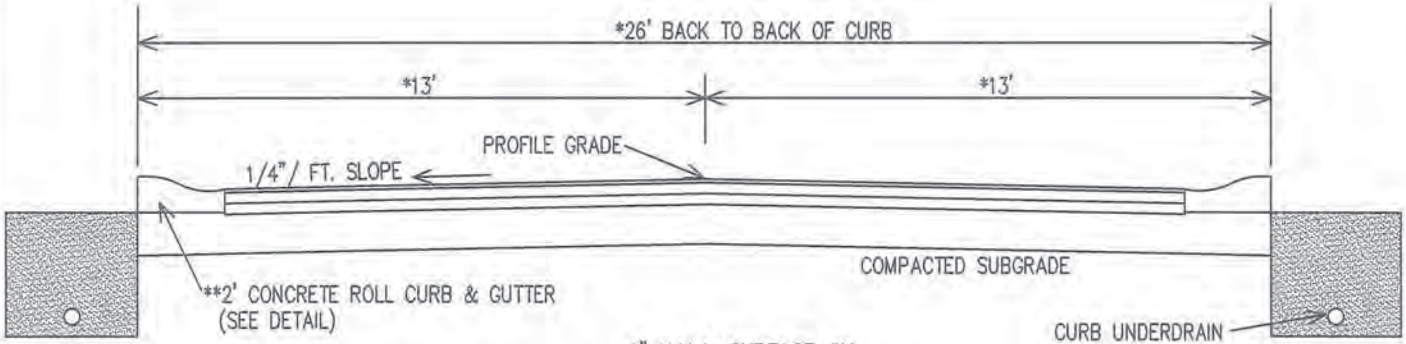
STANDARD DETAIL

J-INLET.DWG



1" H.M.A. SURFACE #11
2.5" H.M.A. INTERMEDIATE #8
3.5" H.M.A. BASE #5
12" LIME STABILIZED BASE

* FOR INDUSTRIAL LOCAL STREETS, TOTAL WIDTH IS 28 FEET AND HALF WIDTH IS 14 FEET.

** FOR INDUSTRIAL AND COMMERCIAL STREETS, USE 2' CONCRETE CURB & GUTTER OR CONCRETE STANDING CURB.

LOCAL ASPHALT STREET SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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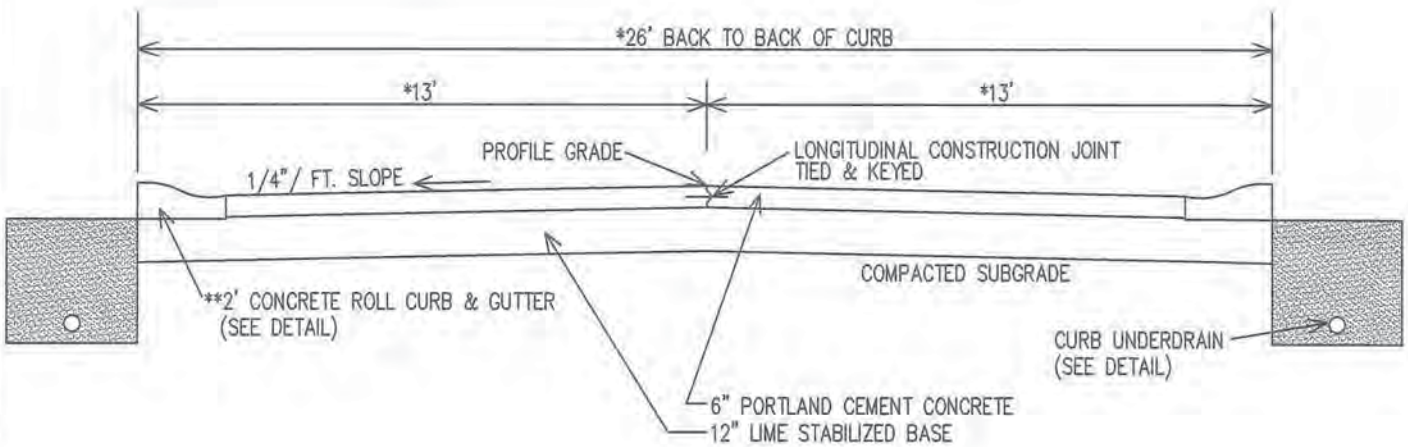
REVISED: ______________

STANDARD DETAIL

LOCALASPHALTSTREET.DWG



* FOR INDUSTRIAL LOCAL STREETS, TOTAL WIDTH IS 28 FEET AND HALF WIDTH IS 14 FEET.

** FOR INDUSTRIAL AND COMMERCIAL STREETS, USE 2' CONCRETE CURB & GUTTER OR CONCRETE STANDING CURB.

LOCAL CONCRETE STREET SECTION DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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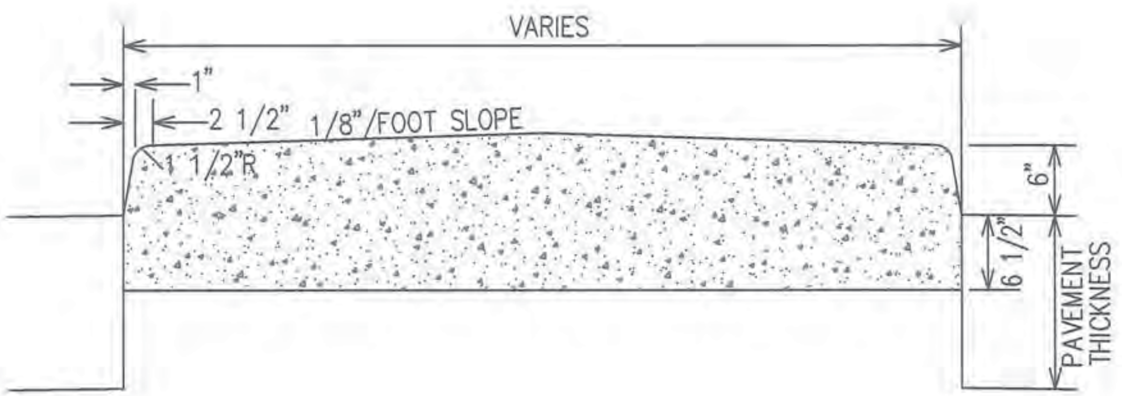
REVISED: ______________________

STANDARD DETAIL

LOCALCONCRETESTREET.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



CONCRETE MEDIAN

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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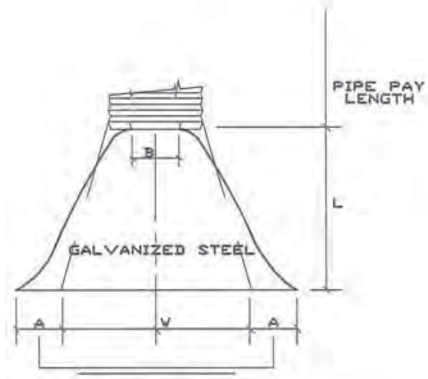
APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______

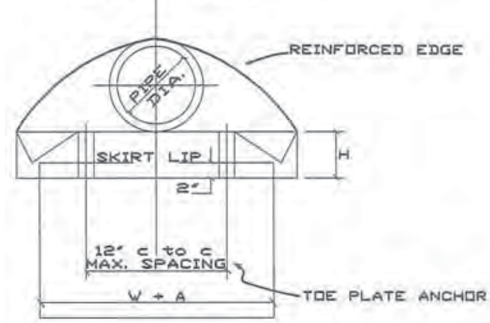
STANDARD DETAIL

MEDIAN.DWG

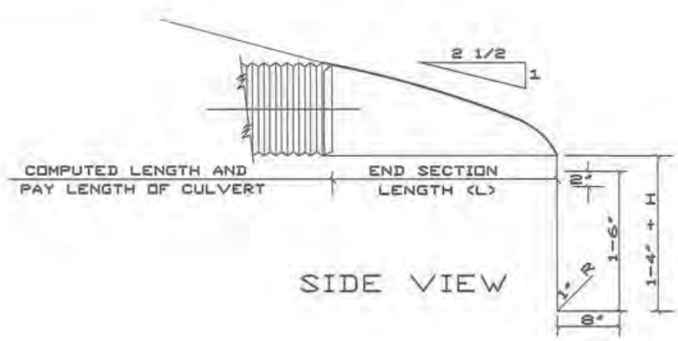


PLAN VIEW

PIPE DIA.	T IN	DIMENSIONS A (1" ±)	B (MAX)	H (1" ±)	L (1 1/2" ±)	W (2" ±)	SLOPE APPROX	BODY
12	.064	6	6	6	21	24	2.5	1PC
15	.064	7	8	6	26	30	2.5	1PC
18	.064	8	10	6	31	36	2.5	1PC
21	.064	9	12	6	36	42	2.5	1PC
24	.064	10	13	6	41	48	2.5	1PC
30	.079	12	16	8	51	60	2.5	1PC
36	.079	14	19	9	60	72	2.5	2PC



END VIEW



SIDE VIEW

METAL END SECTION

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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REVISED: ______________

STANDARD DETAIL

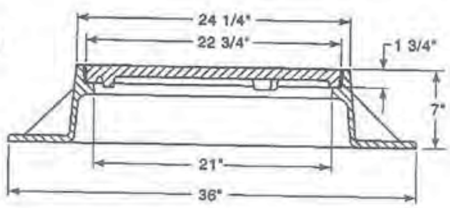
METALENDSECTION.DWG

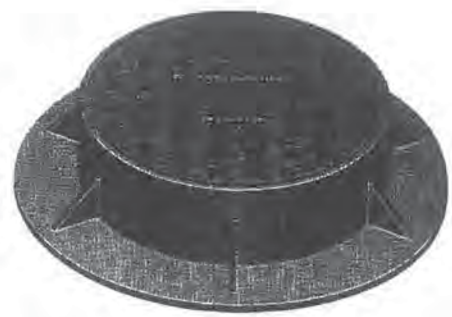
R-1772
Manhole Frame, Solid Lid

Heavy Duty

Also available with Non-Rocking feature. See page 9 for illustration.

Also furnished with 34" diameter flange.





NEENAH OR EQUAL

MANHOLE CASTING

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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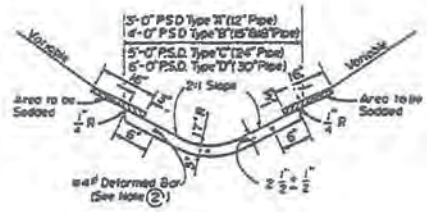
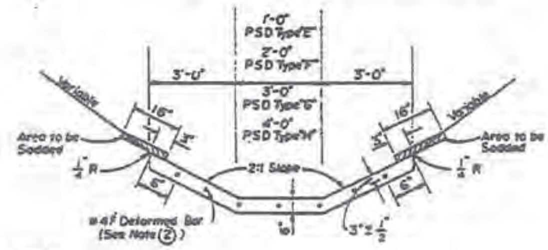
STANDARD DETAIL

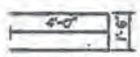
MH–CASTING.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



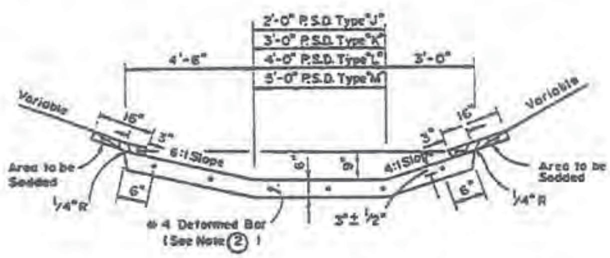
ELEVATION VIEW
PAVED SIDE DITCH TYPES "A" THRU "D"





"U" BAR DETAIL

ELEVATION VIEW
PAVED SIDE DITCH TYPES "E" THRU "H"



ELEVATION VIEW
PAVED SIDE DITCH TYPES "J" THRU "M"

② Reinforcement shall be required for all paved side ditch, cut-off-walls and lugs as shown. The reinforcing steel in the paved side ditch shall be spaced a maximum of one foot on centers.

PAVED SIDE DITCH

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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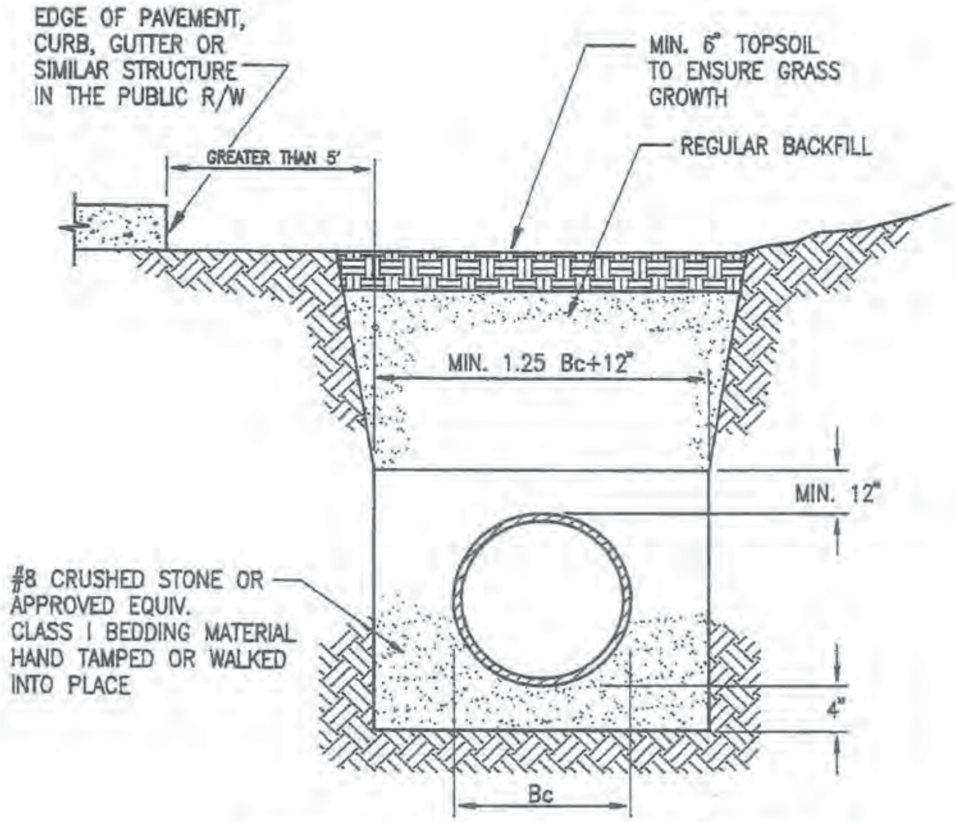
STANDARD DETAIL

PAVEDDITCH.DWG



GREATER THAN 5' FROM EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

A MINIMUM 9" CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

PLASTIC (PVC OR HDPE) PIPE TRENCH DETAIL OUTSIDE 5 FEET OF PAVEMENT

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______ MADISON COUNTY ENGINEER ______ DATE

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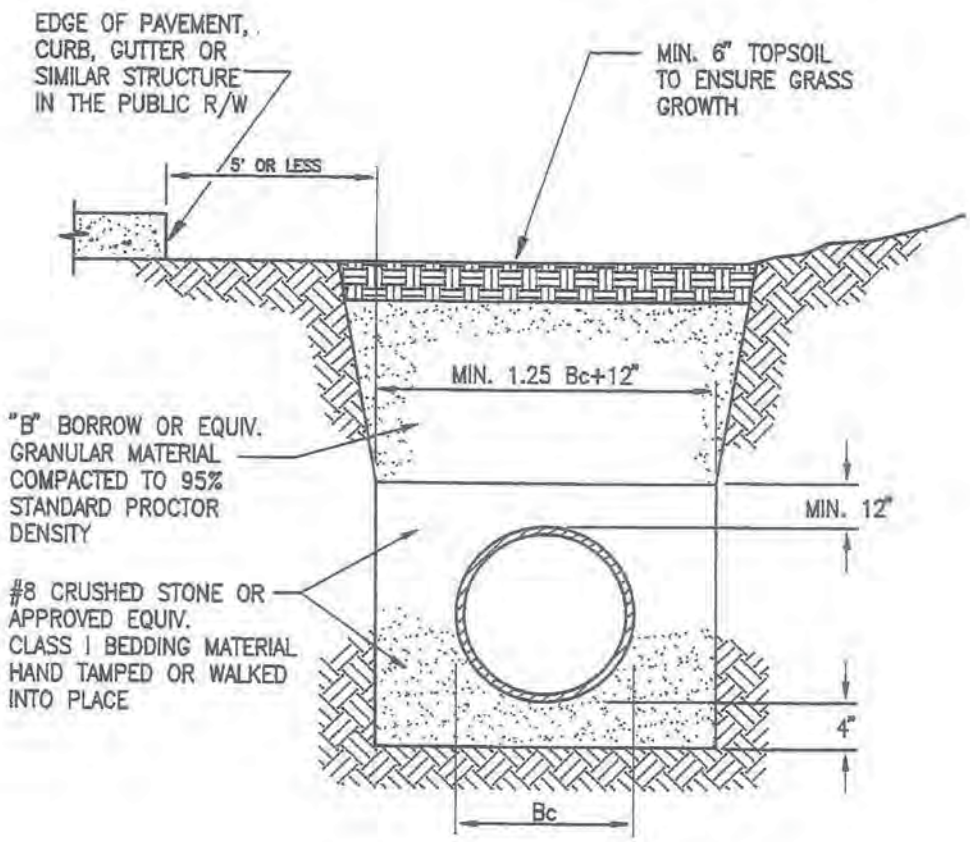
STANDARD DETAIL

PLASTICTRENCH1.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



WITHIN 5" OF EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

A MINIMUM 9" CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

PLASTIC (PVC OR HDPE) PIPE TRENCH DETAIL
WITHIN 5 FEET OF PAVEMENT

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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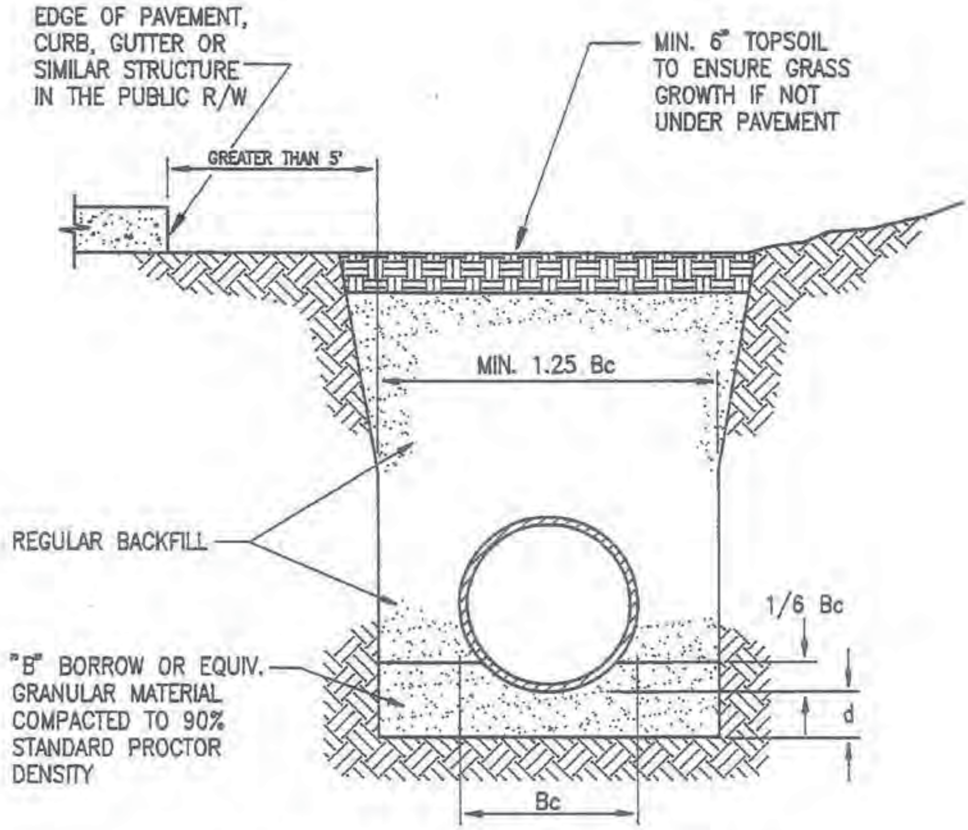
STANDARD DETAIL

PLASTICTRENCH2.DWG



GREATER THAN 5' FROM EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" OF CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

REINFORCED CONCRETE PIPE TRENCH DETAIL OUTSIDE 5 FEET OF PAVEMENT

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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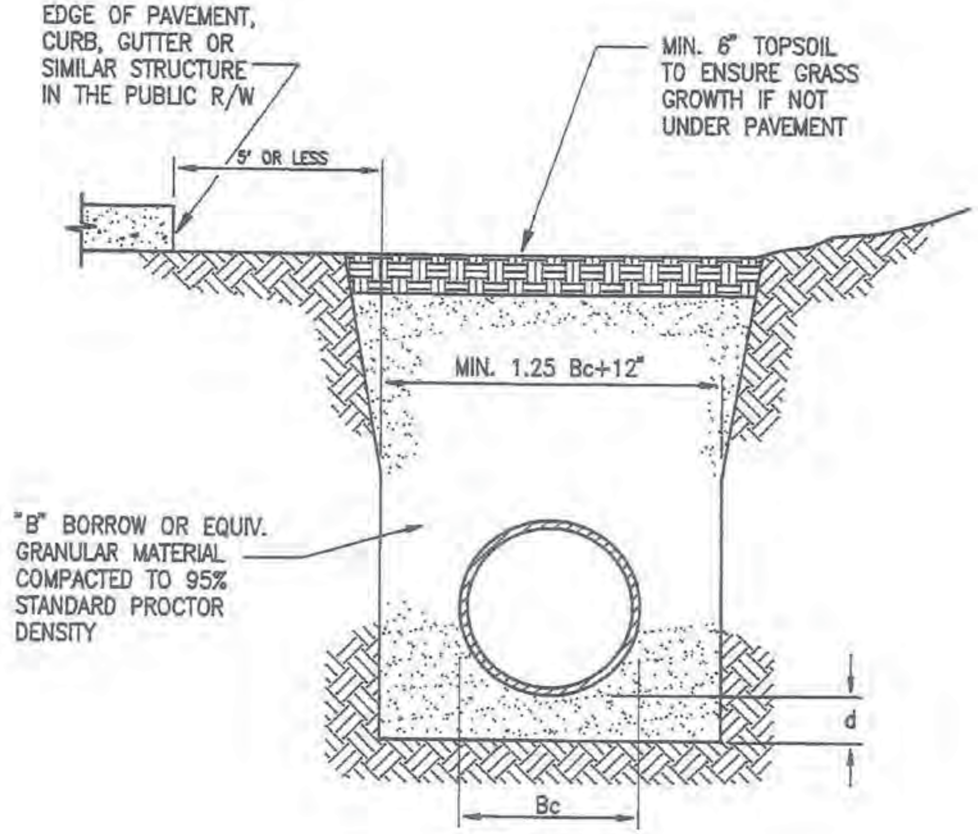
REVISED: ______________________

STANDARD DETAIL

RCPTRENCH1.DWG

STANDARD DETAIL - MADISON COUNTY, INDIANA



WITHIN 5" OF EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" OF CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

REINFORCED CONCRETE PIPE TRENCH DETAIL WITHIN 5 FEET OF PAVEMENT

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

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REVISED: ______

STANDARD DETAIL

RCPTRENCH2.DWG

Rock Chute

Requirements

Contributing drainage area: 100 acres maximum.
Capacity: Peak runoff from 10-yr. frequency, 24-hr. duration storm event.
Apron: Design depends on channel definition (see exhibit below), but is long enough to dissipate runoff energy, set on zero grade, straight and aligned with the receiving stream. (If site conditions require a curve, set it near the upstream end.)
Foundation: Geotextile fabric for stabilization and filtration or well-graded gravel filter layer at least 6 in. thick.

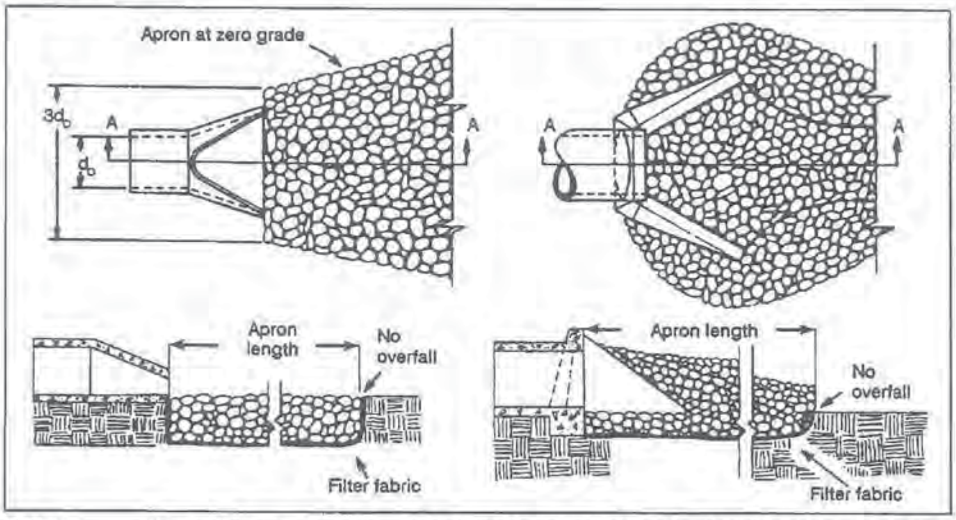

Exhibit **Pipe outlet aprons for a channel (left) that is not well defined and (right) that is well defined.**

ROCK CHUTE

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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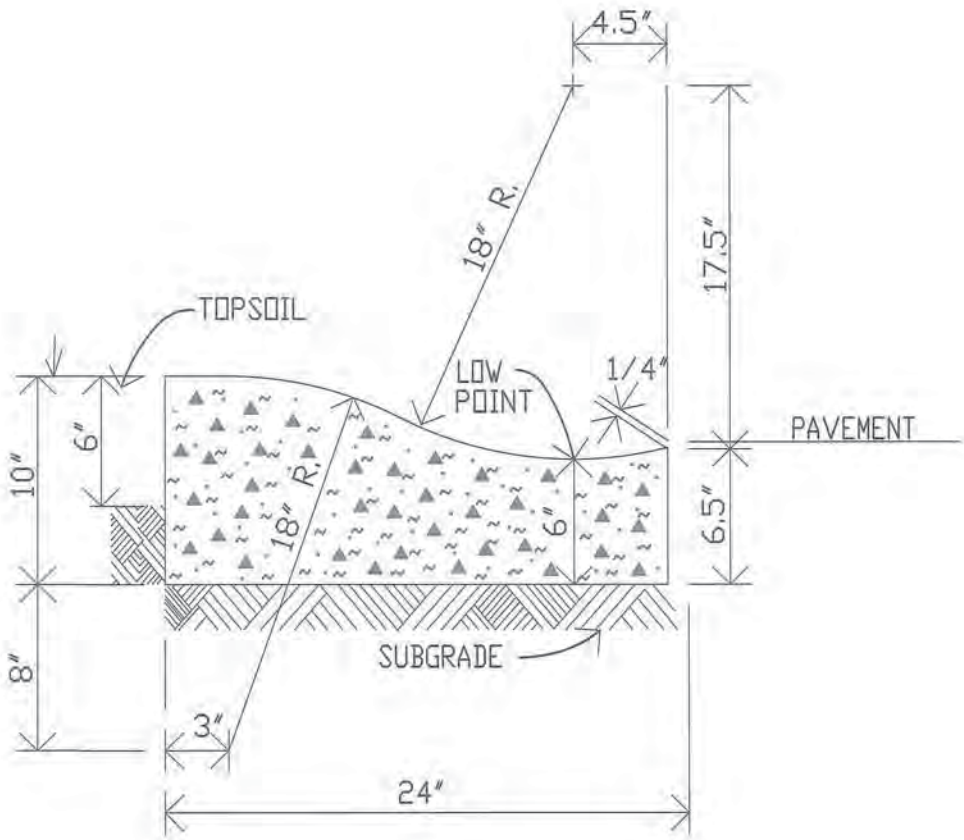
STANDARD DETAIL

ROCKCHUTE.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



2 FOOT CONCRETE ROLL CURB & GUTTER

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ DATE ______

MADISON COUNTY ENGINEER

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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REVISED: ______________________

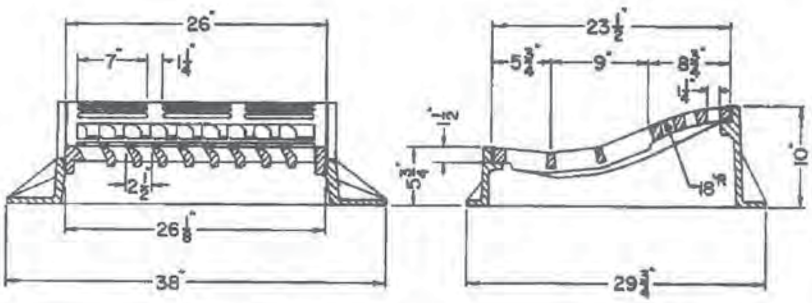
STANDARD DETAIL

ROLLCURB.DWG

R-3501-TR
Inlet for Roll Type Curb

Heavy Duty

Illustrating R-3501-TR (flow right). If flow left is required, order as **R-3501-TL**.



NEENAH OR EQUAL

ROLL CURB, INLINE CASTING
FOR TYPE "A" BOXES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______

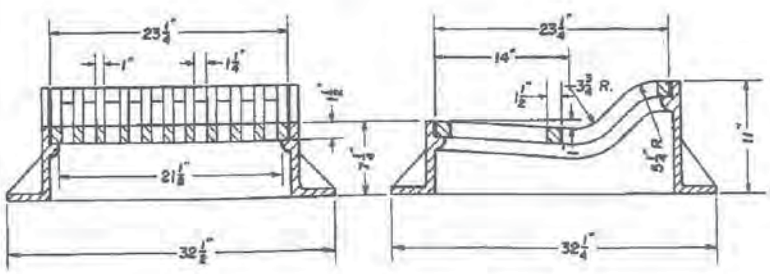
STANDARD DETAIL

ROLL–INLINE–CASTING.DWG

R-3501-N
Inlet for Roll Type Curb

Heavy Duty

Not recommended for bicycle traffic.



NEENAH OR EQUAL

ROLL CURB, LOW POINT CASTING
FOR TYPE "A" BOXES

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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REVISED: ______________________

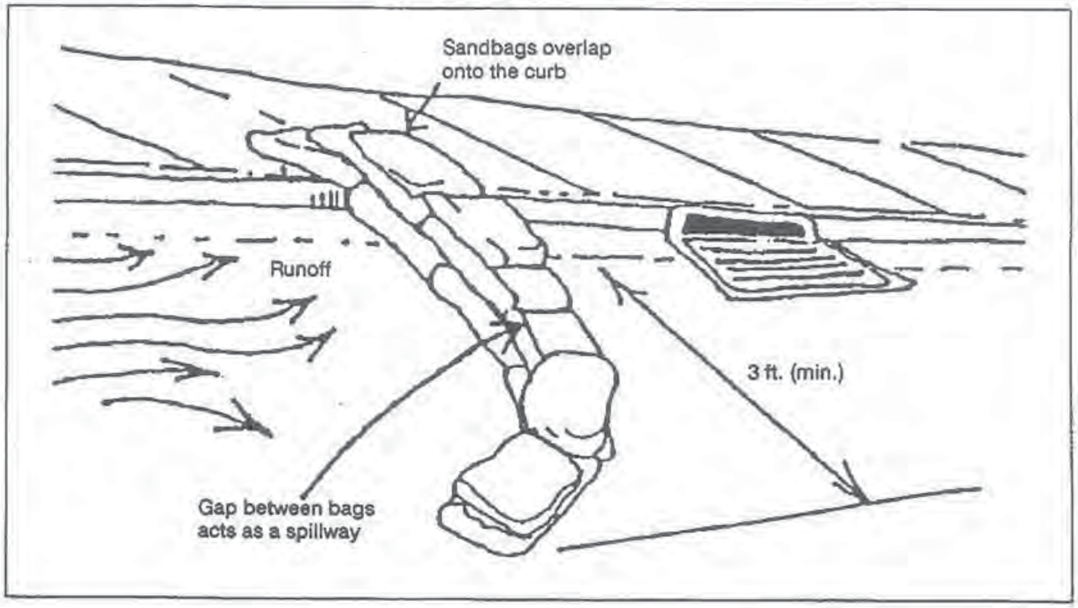
STANDARD DETAIL

ROLL–LOW–CASTING.DWG

Sandbag Curb Inlet Sediment Barrier

Requirements

Location: On curbed paved street down grade from light construction activity (e.g., individual home) and above the inlet.
Contributing drainage area: 1 acre maximum.
Capacity: Runoff from a 2-yr. frequency, 24-hr. duration storm event entering the storm drain without bypass flow.
Height: 1-3 layers of sandbags (as necessary)
Length: As needed to intercept runoff (3 ft. minimum).
Traffic barricades (optional): As needed to prevent vehicles from hitting the barrier.



SANDBAG CURB INLET SEDIMENT BARRIER

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

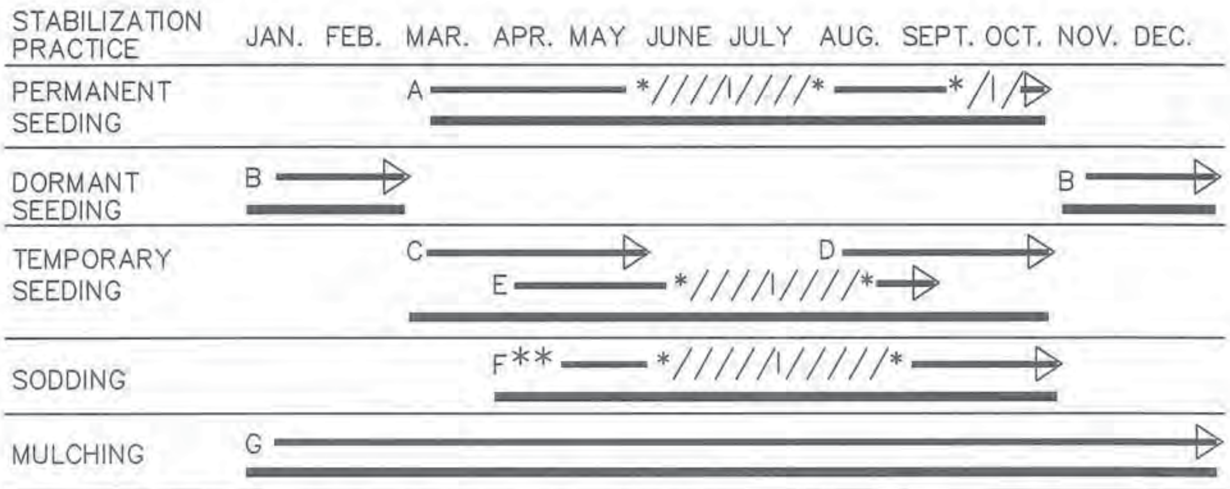
APPROVED: ______ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______

STANDARD DETAIL

SANDBAG.DWG



A = KENTUCKY BLUEGRASS 40 LBS/ACRE; CREEPING RED FESCUE 40 LBS/ACRE; PLUS 2 TONS STRAW MULCH/ACRE, OR ADD ANNUAL RYEGRASS 20 LBS/ACRE.

B = KENTUCKY BLUEGRASS 60 LBS/ACRE; CREEPING RED FESCUE 60 LBS/ACRE; PLUS 2 TONS STRAW MULCH/ACRE, OR ADD ANNUAL RYEGRASS 30 LBS/ACRE.

C = SPRING OATS 3 BUSHEL/ACRE.

D = WHEAT OR RYE 2 BUSHEL/ACRE.

E = ANNUAL RYEGRASS 40 LBS/ACRE.

F = SOD

G = STRAW MULCH 2 TONS/ACRE.

/I/ IRRIGATION NEEDED DURING JUNE, JULY, AND/OR SEPTEMBER

** IRRIGATION NEEDED FOR 2 TO 3 WEEKS AFTER APPLYING SOD

SEASONAL SOIL PROTECTION CHART

(NO SCALE)

SEEDING CHART

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ ________
MADISON COUNTY ENGINEER DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________
DATE

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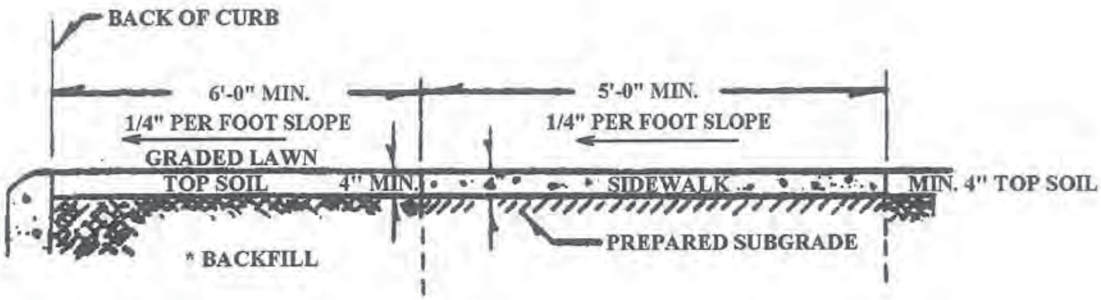
REVISED: ______________

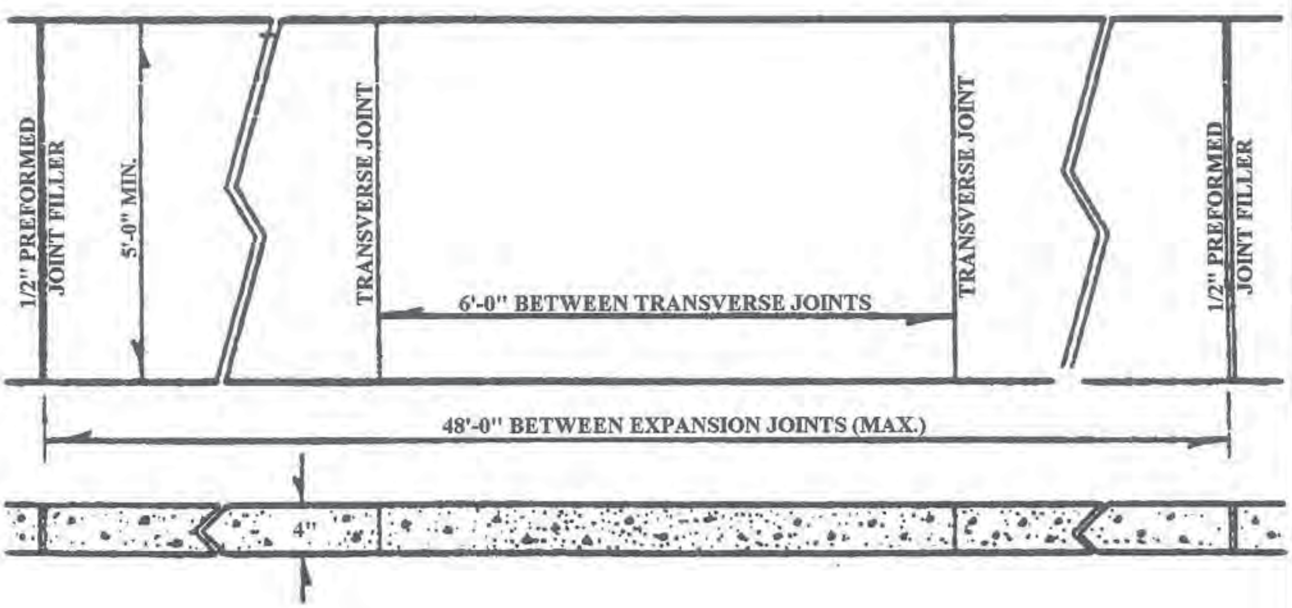
STANDARD DETAIL

SEEDCHART.DWG



* THE SPACE BEHIND THE CURB SHALL BE FILLED WITH SUITABLE MATERIAL TO THE REQUIRED ELEVATION AND COMPACTED IN LAYERS NOT TO EXCEED 6" IN DEPTH.

TYPICAL SIDEWALK SECTION



CONCRETE SIDEWALK

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ____________________ ______
MADISON COUNTY ENGINEER DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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REVISED: ____________________

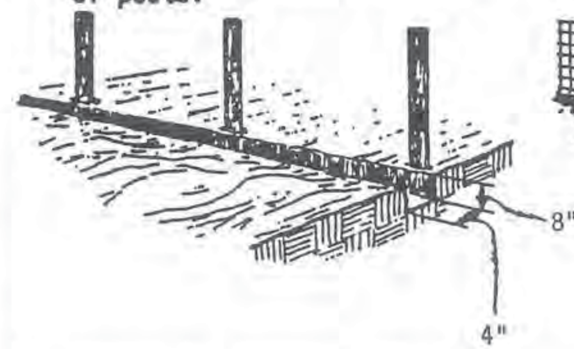
STANDARD DETAIL

SIDEWALK.DWG

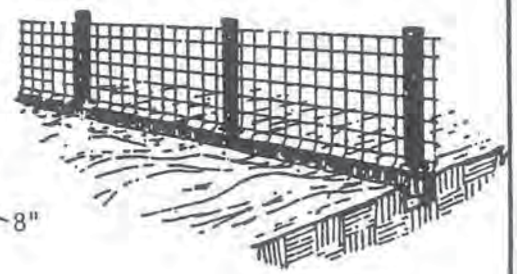
STANDARD DETAIL – MADISON COUNTY, INDIANA

Silt Fence (SF)

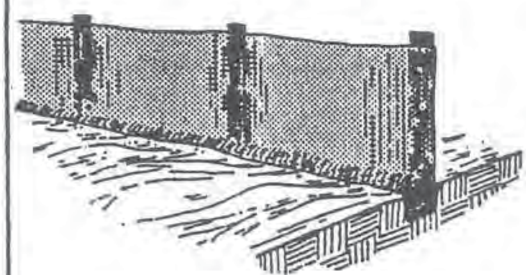
1. Set posts and excavate a 4"x4" trench upslope along the line of posts.



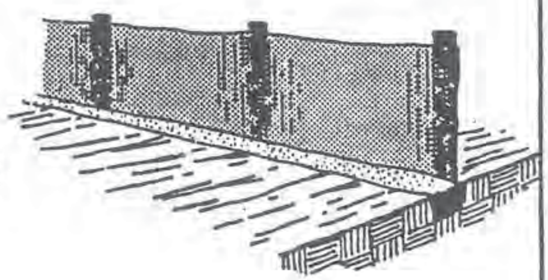
2. Staple wire fencing to the posts.



3. Attach the filter fabric to the wire fence and extend it into the trench.



4. Backfill and compact the excavated soil.



Extension of fabric and wire into the trench.

SILT FENCE DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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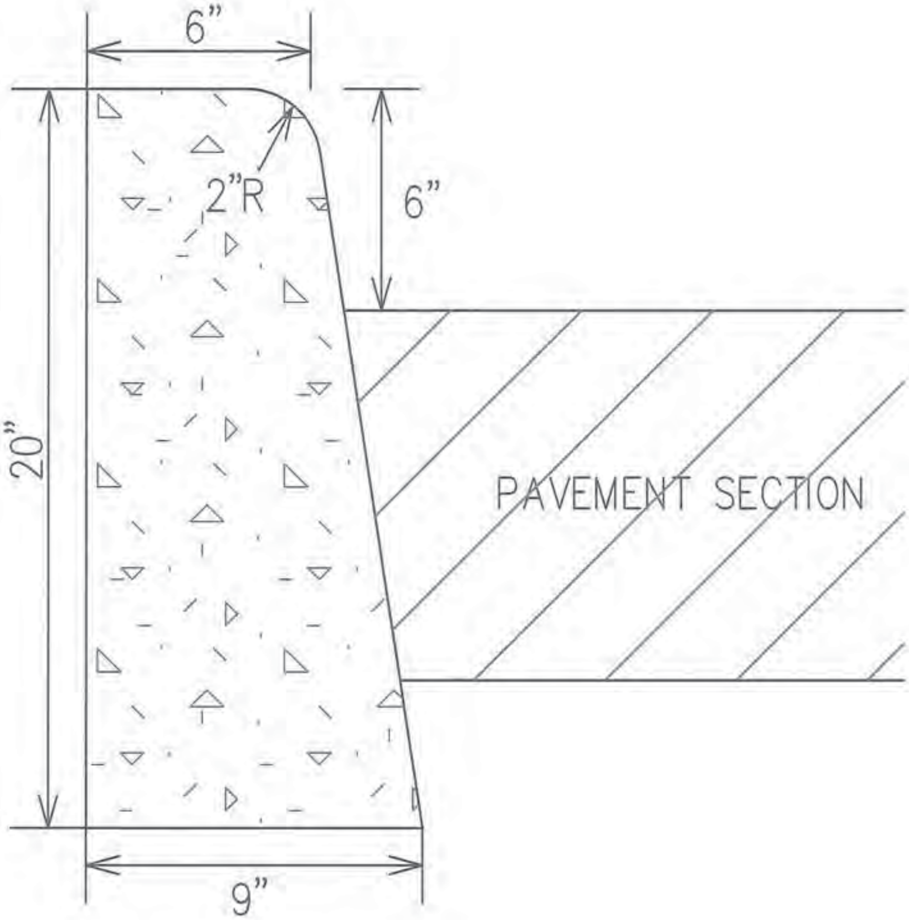
REVISED: ______________

STANDARD DETAIL

SILTFENCE.DWG



STANDING CONCRETE CURB

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ ______
MADISON COUNTY ENGINEER DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______
DATE

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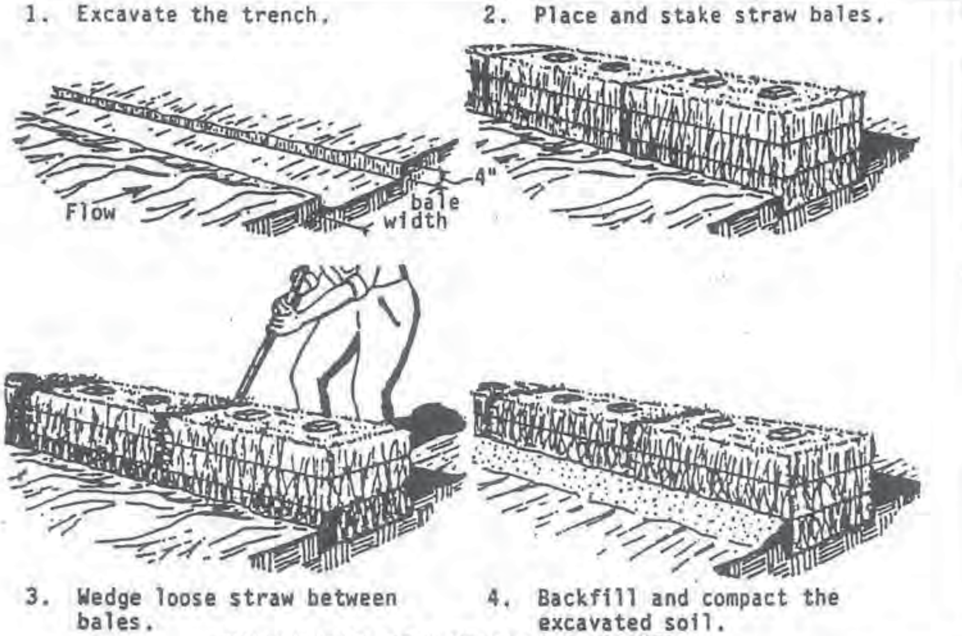
REVISED: ______________________

STANDARD DETAIL

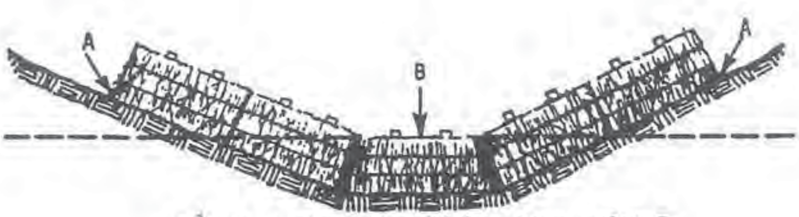
STANDINGCURB.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA

Straw Bale Barrier (SBB)



CONSTRUCTION OF A STRAW BALE BARRIER



Points A should be higher than point B

PROPER PLACEMENT OF STRAW BALE BARRIER IN DRAINAGE WAY

STRAW BALE BARRIER DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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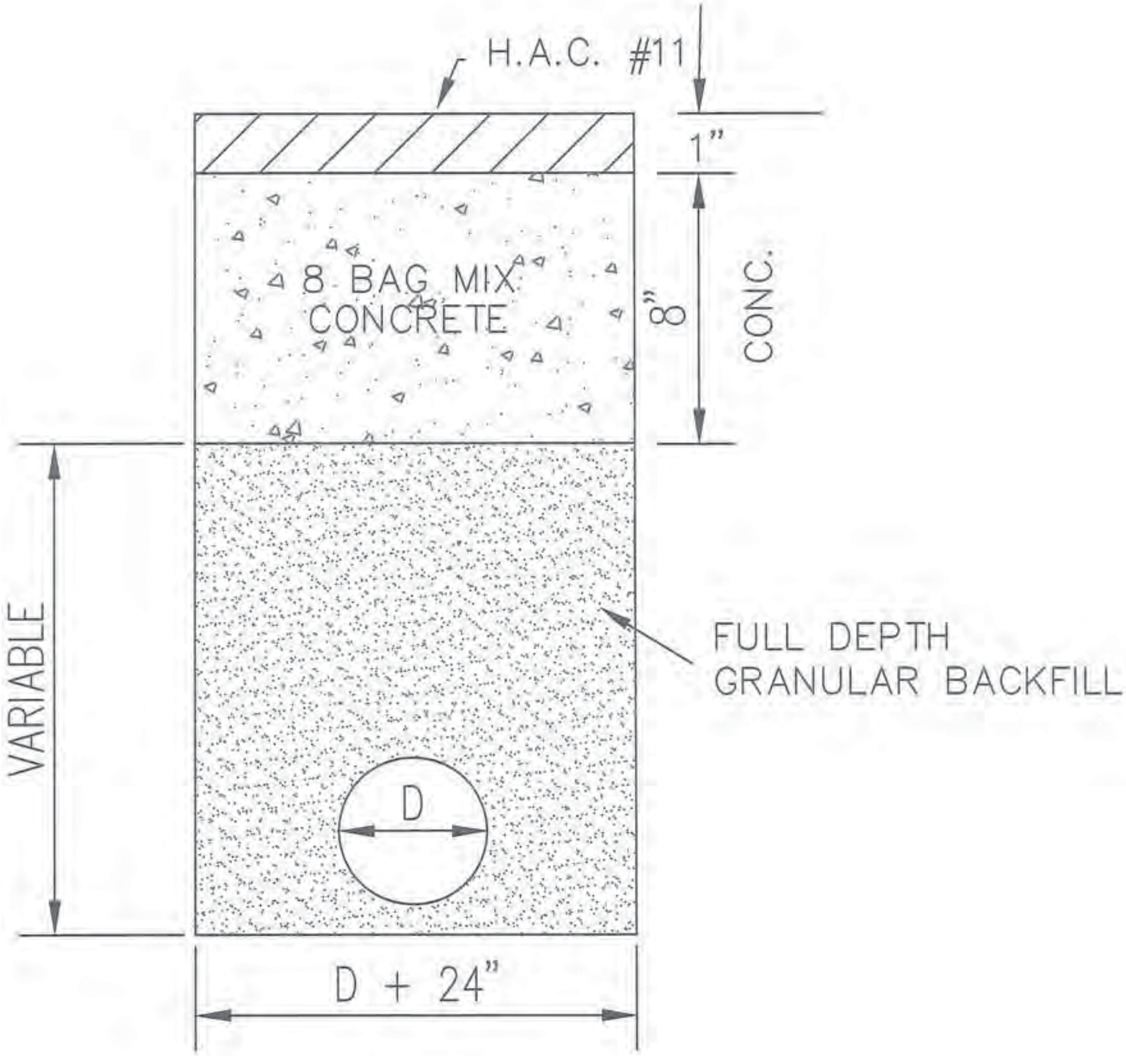
REVISED: ______________

STANDARD DETAIL

STRAWBALE.DWG

STANDARD DETAIL – MADISON COUNTY



STREET CUT REPLACEMENT SECTION

DRAWING NOT TO SCALE

MADISON COUNTY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY COMMISSIONERS: ______________________ ______ DATE

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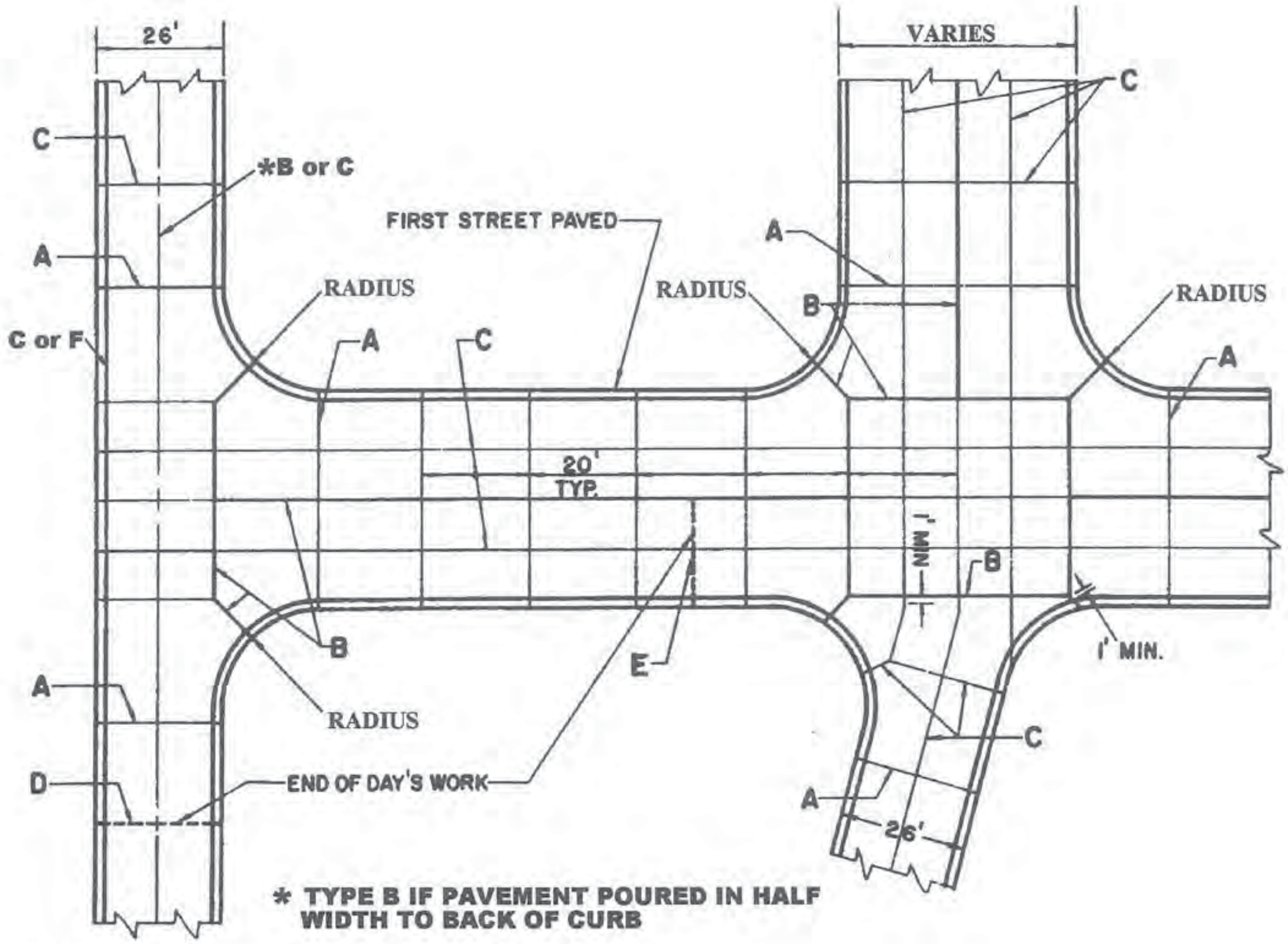
REVISED: ______________________

STANDARD DETAIL

STREETCUT.DWG



CONCRETE STREET JOINTS

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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REVISED: ______________________

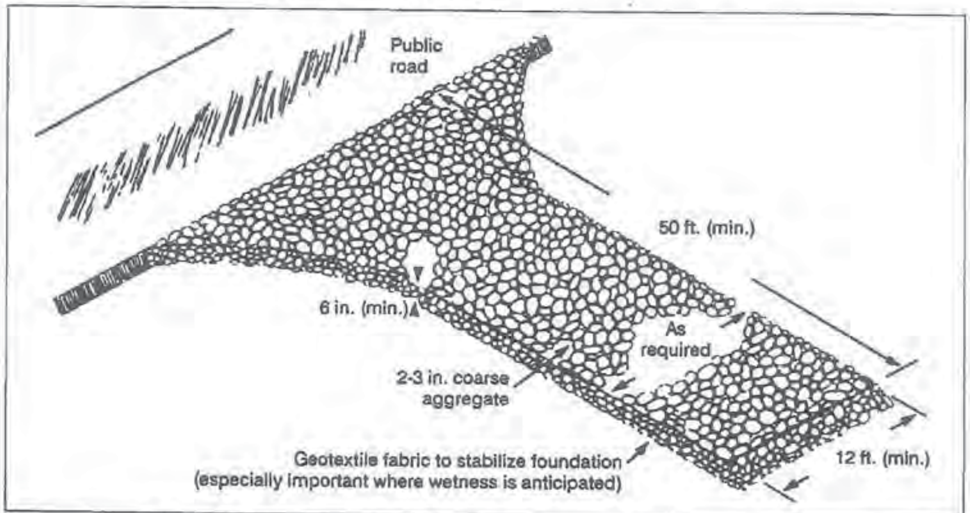
STANDARD DETAIL

STREETJOINTS.DWG

Temporary Gravel Construction Entrance/Exit Pad

Requirements

Material: 2-3 in. washed stone (INDOT CA No. 2) over a stable foundation.
Thickness: 6 in. minimum
Width: 12 ft. minimum or full width of entrance/exit roadway, whichever is greater.
Length: 50 ft. minimum. The length can be shorter for small sites such as for an individual home.
Washing facility (optional): Level area with 3 in. washed stone minimum or a commercial rack, and waste water diverted to a sediment trap or basin.
Geotextile fabric underliner: May be used under wet conditions or for soils within a high seasonal water table to provide greater bearing strength.



Plan of a temporary gravel construction entrance/exit pad.

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT PAD — DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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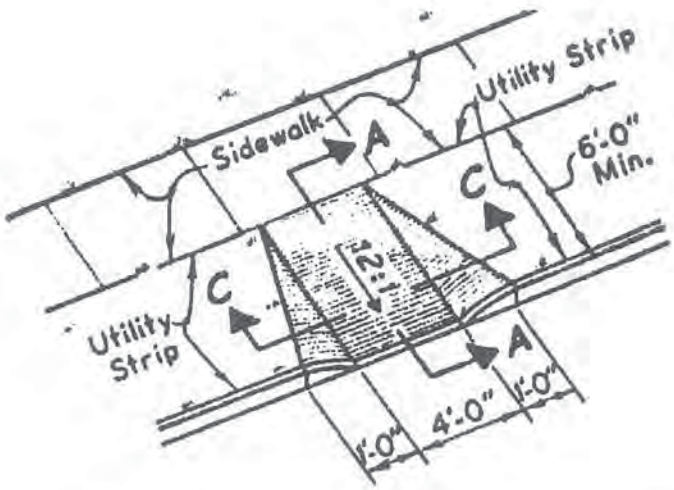
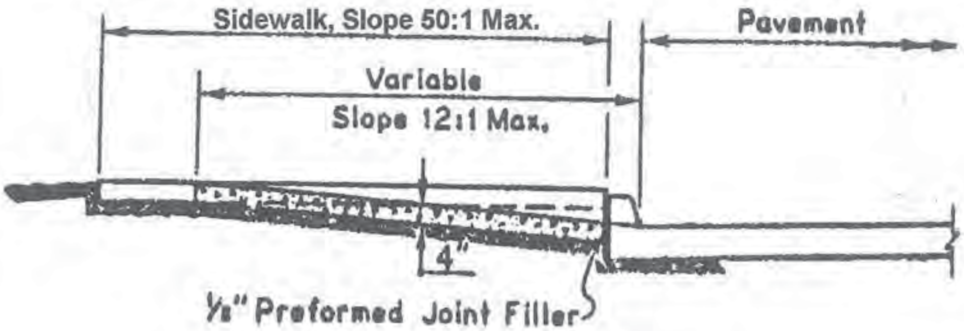
REVISED: ______________________

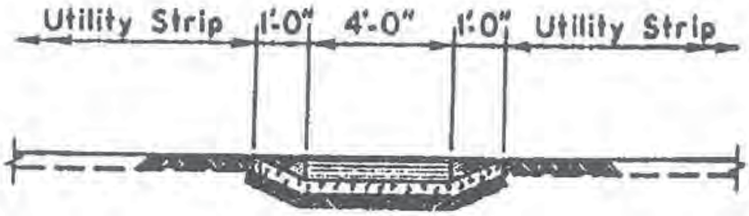
STANDARD DETAIL

TEMPDRIVE.DWG





SECTION A-A



SECTION C-C

NOTES: 1. DIMENSIONS ARE BASED ON 6 INCH CURB HEIGHT AND SHALL PROPORTIONALLY ADJUSTED FOR OTHER CURB HEIGHTS.
2. A 3 FOOT MINIMUM WIDTH RAMP MAY BE USED WHEN EXISTING SPACE PROHIBITS THE CONSTRUCTION OF THE 4 FOOT WIDE RAMP.
3. THE BOTTOM EDGE OF THE CURB RAMP SHALL BE FLUSH WITH THE EDGE OF THE ADJACENT PAVEMENT AND GUTTER LINE.

TYPE "C" SIDEWALK RAMP

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

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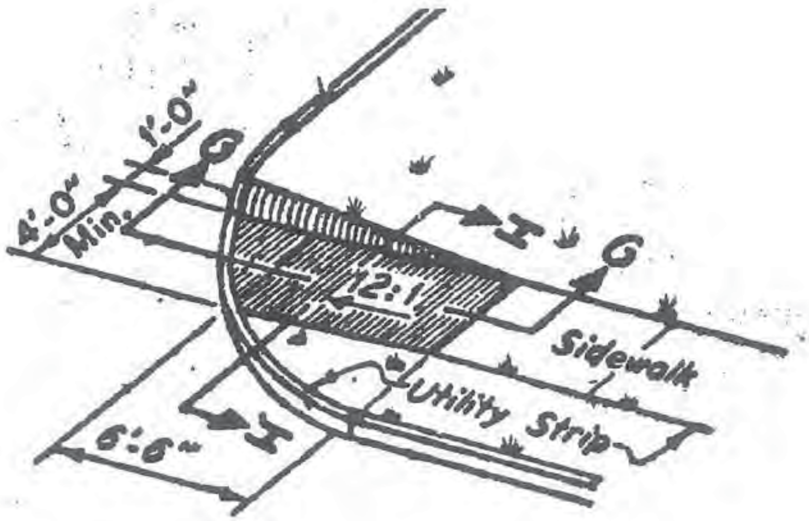
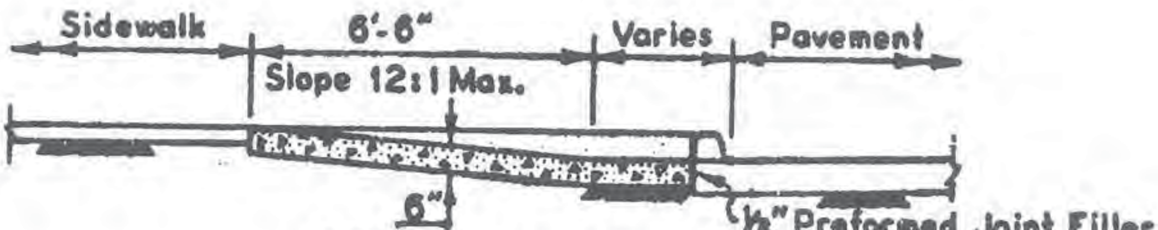
REVISED: ______________________

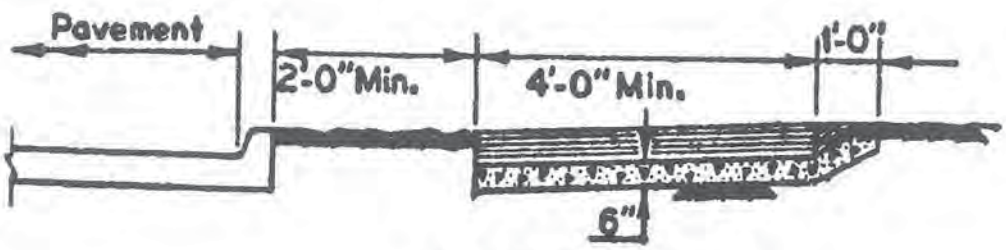
STANDARD DETAIL

TYPECRAMP.DWG





SECTION G–G



SECTION H–H

NOTES: 1. DIMENSIONS ARE BASED ON 6 INCH CURB HEIGHT AND SHALL BE PROPORTIONALLY ADJUSTED FOR OTHER CURB HEIGHTS.
2. THE BOTTOM EDGE OF THE CURB RAMP SHALL BE FLUSH WITH THE EDGE OF THE ADJACENT PAVEMENT AND GUTTER LINE.

TYPE "H" SIDEWALK RAMP

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

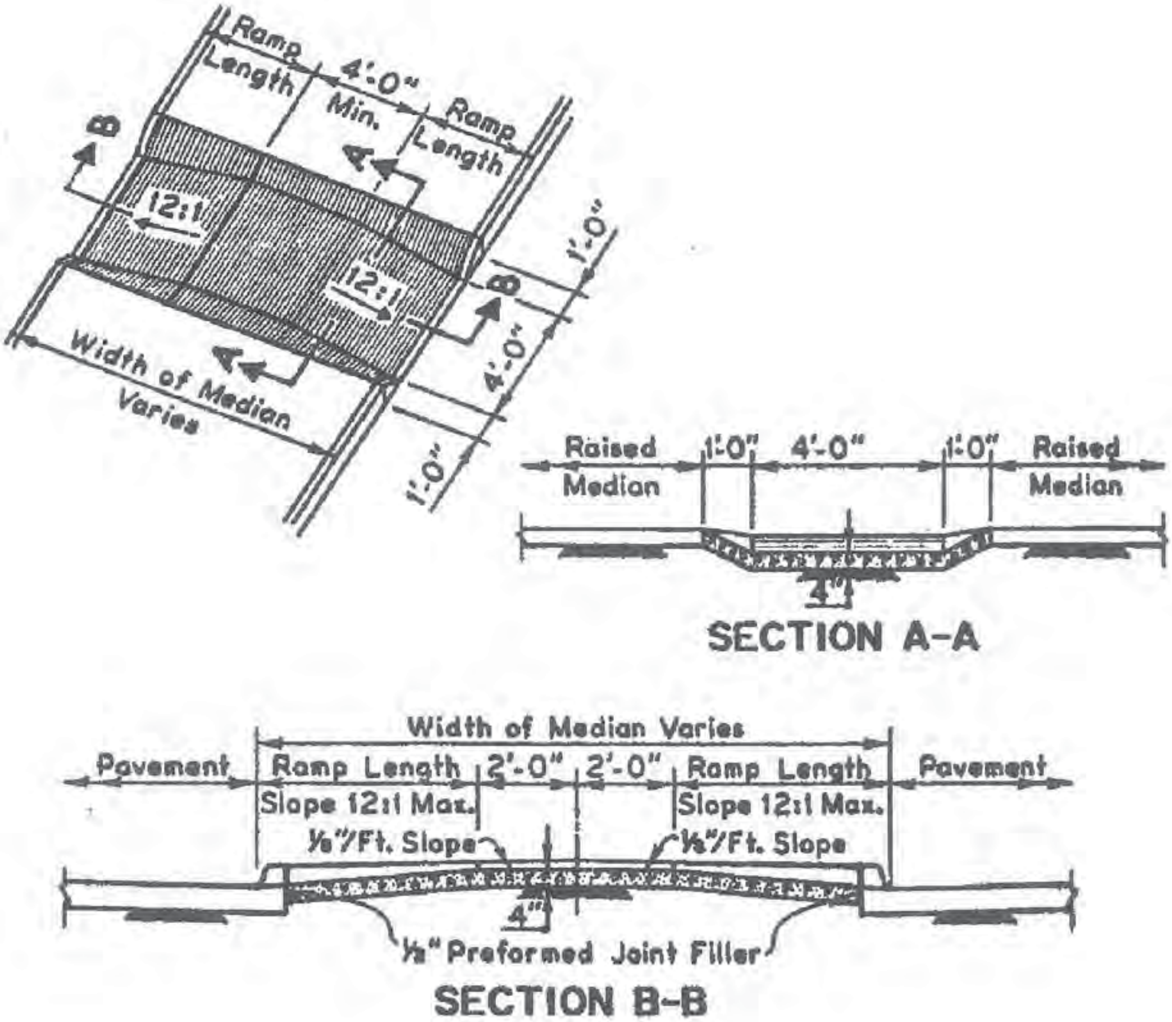
APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

REVISED: ______

STANDARD DETAIL

TYPEHRAMP.DWG



NOTES: 1. A 3 FOOT MINIMUM WIDTH RAMP MAY BE USED WHEN EXISTING SPACE PROHIBITS THE CONSTRUCTION OF THE 4 FOOT WIDE RAMP.
2. THE BOTTOM EDGE OF THE CURB RAMP SHALL BE FLUSH WITH THE EDGE OF THE ADJACENT PAVEMENT AND GUTTER LINE.

TYPE "L" SIDEWALK RAMP

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

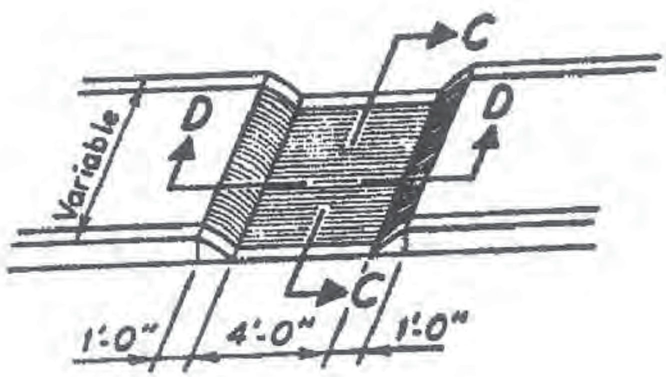
APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

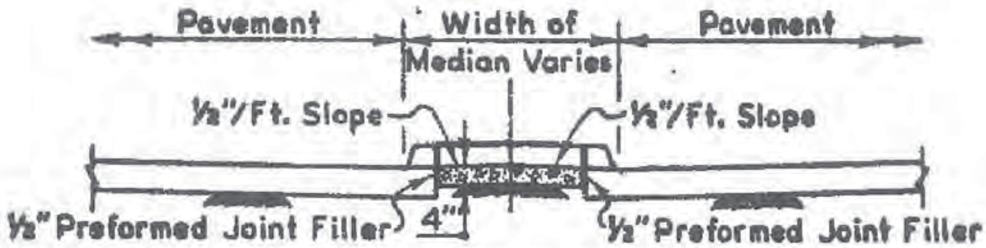
APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

REVISED: ______________

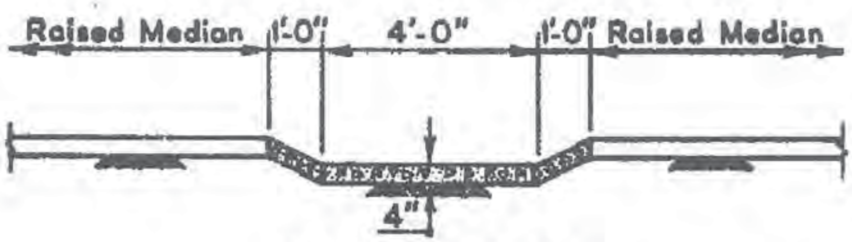
STANDARD DETAIL

TYPELRAMP.DWG





SECTION C–C



SECTION D–D

NOTES: 1. A 3 FOOT MINIMUM WIDTH RAMP MAY BE USED WHEN EXISTING SPACE PROHIBITS THE CONSTRUCTION OF THE 4 FOOT WIDE RAMP.
2. THE BOTTOM EDGE OF THE CURB RAMP SHALL BE FLUSH WITH THE EDGE OF THE ADJACENT PAVEMENT AND GUTTER LINE.

TYPE "M" SIDEWALK RAMP

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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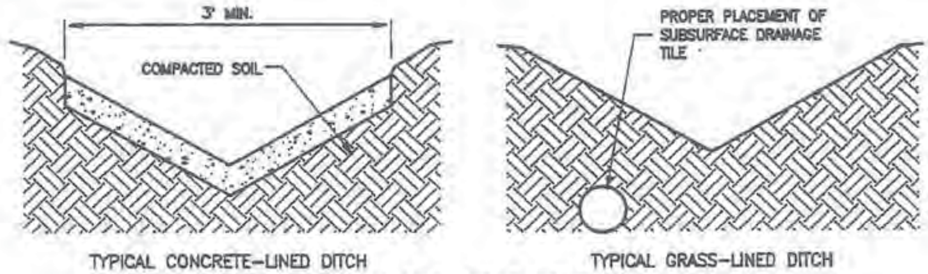
REVISED: ______________

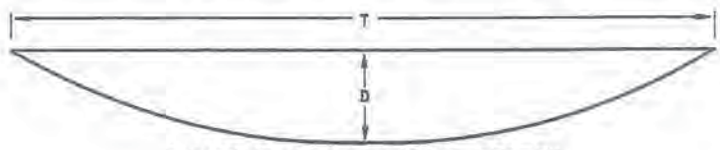
STANDARD DETAIL

TYPEMRAMP.DWG

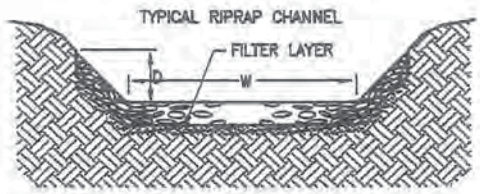
STANDARD DETAIL – MADISON COUNTY, INDIANA

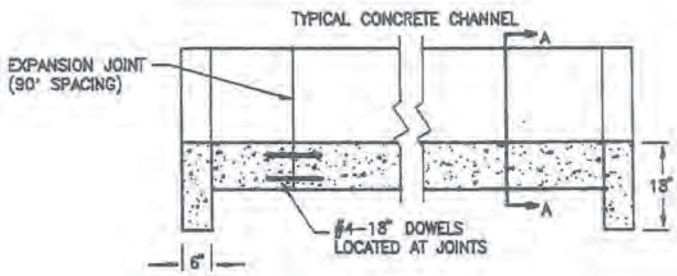


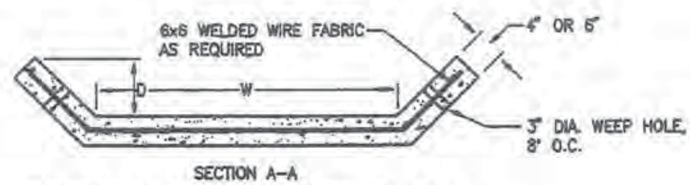
TYPICAL VEE CROSS–SECTIONS



PARABOLIC WATERWAY CROSS–SECTION







TRAPEZOIDAL WATERWAY CROSS–SECTIONS

TYPICAL WATERWAY CROSS SECTIONS

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ________ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ________ DATE

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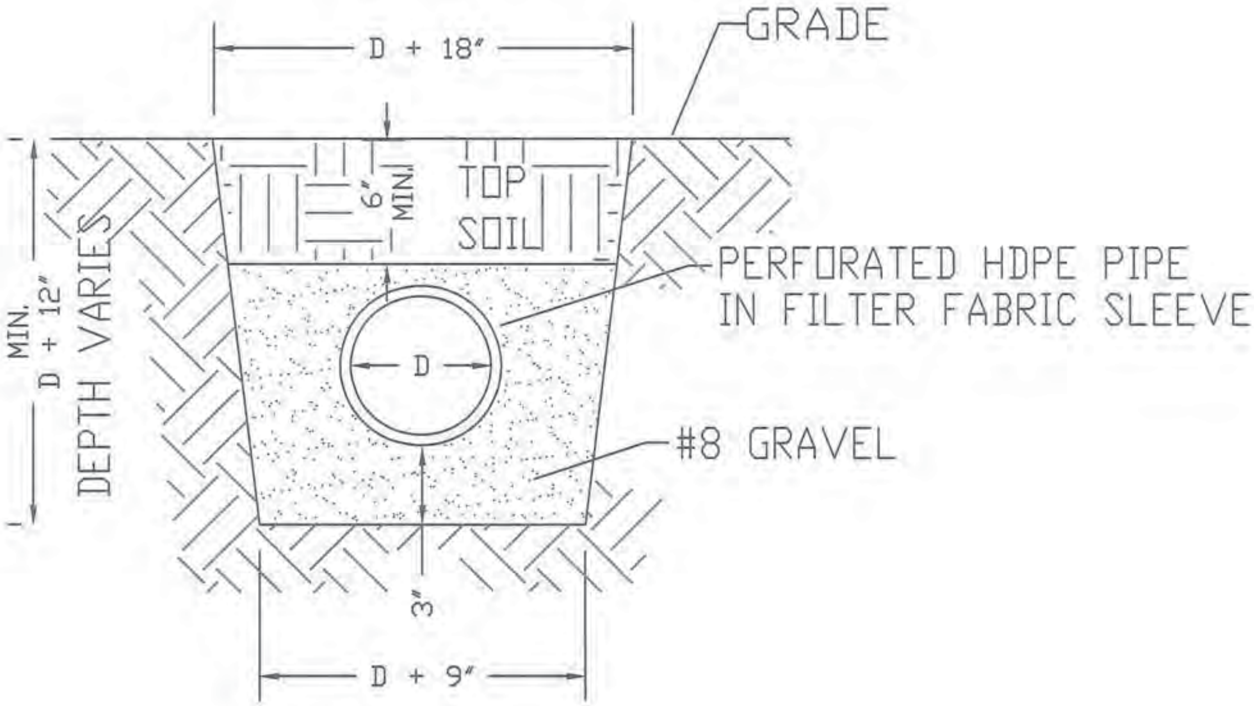
REVISED: ______________

STANDARD DETAIL

TYPWATERWAY.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



SUBSURFACE TILE UNDERDRAIN DETAIL

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ MADISON COUNTY ENGINEER ______ DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______ DATE

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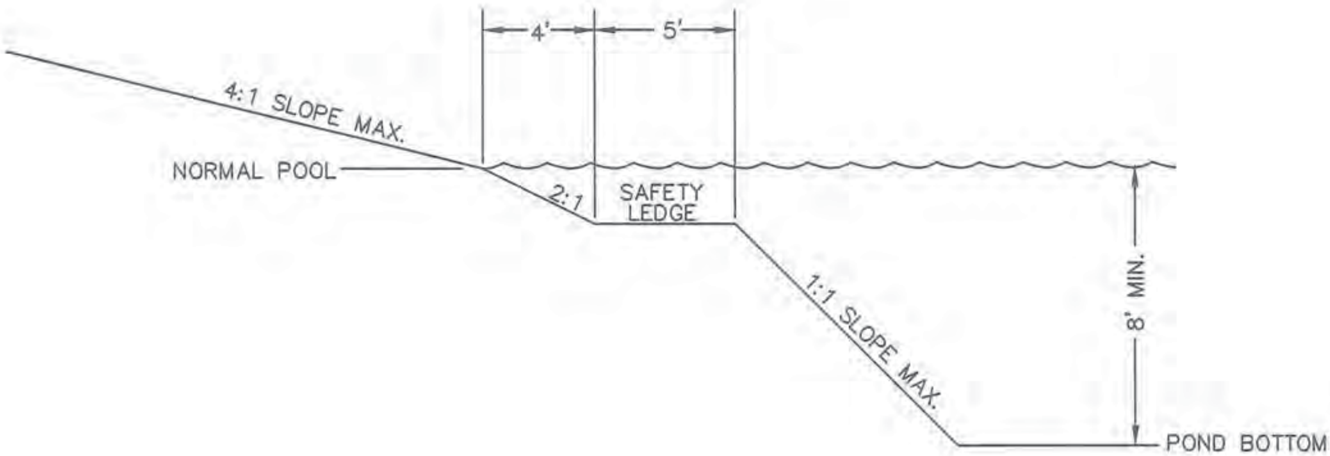
REVISED: ______________

STANDARD DETAIL

UNDERDRAIN.DWG

STANDARD DETAIL – MADISON COUNTY, INDIANA



WET BOTTOM DETENTION POND
CROSS SECTION

DRAWING NOT TO SCALE

MADISON COUNTY HIGHWAY ENGINEER'S OFFICE

APPROVED: ______________________ ______
MADISON COUNTY ENGINEER DATE

APPROVED: MADISON COUNTY BOARD OF COMMISSIONERS: ______
DATE

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REVISED: ______________

STANDARD DETAIL

WETBOTTOMPOND.DWG

APPENDIX F

FORMS

STORMWATER PERMIT APPLICATION CHECKLIST

NOTICE OF INTENT--- STATE FORM #47487

CONSTRUCTION INSPECTION LOG

CERTIFICATION OF COMPLETION

NOTICE OF TERMINATION — STATE FORM #51514

NOTICE OF TERMINATION INSPECTION

INDIVIDUAL LOT TYP. EROSION & SEDIMENT CONTROL

APPLICATION FOR CONNECTION TO REGULATED DRAIN

POST-CONSTRUCTION BMP INSPECTION CHECKLISTS

- BIORETENTION
- DETENTION POND
- FILTER STRIP
- INFILTRATION BASIN
- INFILTRATION TRENCH
- MEDIA FILTRATION
- VEGETATED SWALE
- WETLAND

The included forms not otherwise specifically a part of the Madison County Drainage Ordinance but required by State and Federal Law are for convenience and information only.

It is the applicants responsibility to insure that all other required Federal, State and Local permits have been secured.

Madison County
Application for Stormwater Permit
(to be completed by Applicant)

Project Name:	
General Location:	
File Number:	Date Completed:

1. Application Fee

	Check Attached

2. Notice of Intent

	Complete Notice of Intent – State Form # 47487

3. Construction Plans

	Project narrative and supporting documents, including the following information.	
		An index indicating the location, in the construction plans, of all information required by this subsection.
		Description of the nature and purpose of the project.
		A copy of a legal boundary survey for the site, performed in accordance with Rule 12 of Title 865 of the Indiana Administrative Code or any applicable and subsequently adopted rule or regulation limits, including all drainage easements and wetlands.
		Soil properties, characteristics, limitations, and hazards associated with the project site and the measures that will be integrated in the project to overcome or minimize adverse soil conditions.
		General construction sequence of how the project site will be built, including phases of construction.
		14-Digit Watershed Hydrologic Unit Code
		A reduced plat or project site map showing the lot numbers, lot boundaries, easements, and road layout and names. The reduced map must legible and submitted on a sheet or sheets no larger than eleven (11) inches by seventeen (17) inches for all phases or section of the project site.
		A topographic map of the land to be developed and such adjoining land whose topography may affect the layout or drainage of the development. The contour intervals shall be one (1) foot when slopes are less than or equal to two percent (<2%) and shall be two (2) feet when slopes exceed two percent (>2%). All elevations shall be given in North American Vertical Datum of 1988 (NAVD). The horizontal datum of topographic map shall be based on Indiana State Plane Coordinates, NAD83. The map will contain a notation indicating this datum information. a.) If the project site is less than or equal to two (2) acres in total land area, the topographic map shall include all topography of land surrounding the site to a distance of at least one hundred (100) feet. b.) If the project site is greater than two (2) acres in total land area, the topographic map shall include all topography of land surrounding the site to a distance of at least two hundred (200) feet.
		Identification of any other state of federal water quality permits that are required for construction activities associated with the owner's project site.
		Proof of Errors and Omissions Insurance for the registered professional engineer or licensed surveyor showing a minimum amount of $1,000,000 in coverage.
	Vicinity map depicting the project site location in relationship to recognizable local landmarks, towns, and major roads, such as a USGS topographic quadrangle map, or county or municipal road map.	

	An existing project site layout that must include the following, information :	
		Location, name, and normal water level of all wetlands, lakes, ponds, and water courses on, or adjacent to, the project site.
		Location of all existing structures on the project site.
		One hundred (100) year floodplains, floodway fringes, and floodways. Please note if none exists.
		Soil map of the predominant soil types, as determined by the United States Department of Agriculture (USDA), Natural Resources Conservation Services (NRCS) Soil Survey, or as determined by a soil scientist. Hydrologic classification for soils should be shown when hydrologic methods requiring soils information are used. A soil legend must be included with the soil map.
		Identification and delineation of vegetative cover such as grass, weeds, brush, and trees on the project site.
		Location of storm, sanitary, combined sewer, and septic tank systems and outfalls.
		Land use of all adjacent properties
		Identification and delineation of sensitive areas.
		Existing topography at a contour interval appropriate to indicate drainage patterns
		The location of regulated drains, farm drains, inlets and outfalls, if any of record.
		Location of all existing cornerstones within the proposed development and a plan to protect and preserve then.
	Final project site layout, including the following information:	
		Location of all proposed site improvements, including roads, utilities, lot delineation and identification, proposed structures, and common areas.
		One hundred (100) year floodplains, floodway fringes, and floodways. Please note is none exists.
		Proposed final topography, at a contour interval appropriate to indicate drainage patterns.
	A grading plan, including the following information:	
		Delineation of all proposed land disturbing activities, including off-site activities that will provide services to the project site.
		Location of all soil stockpiles and borrow areas.
		Information regarding any off-site borrow, stockpile, or disposal areas that are associated with a project site, and under the control of the project site owner.
		Existing and proposed topographic information.
	A drainage plan, including the following information.	
		An estimate of the peak discharge, based on the ten (10) year storm event, of the project site for post-construction conditions.
		The Proposed 100-year and 10-year release rates determined for the site, showing the methodology used to calculate them and detailing considerations given to downstream restrictions (if any) that may affect the calculated allowable release rates.
		Calculation showing peak runoff rate after development for the 10-year and 100- year return period 24-hour storms do not exceed the respective allowable release runoff rates.
		Location, size, and dimensions of all existing streams to be maintained and new drainage systems such as culverts, bridges, storm sewers, conveyance channels, and 100-year overflow paths / ponding areas shown as hatched areas, along with the associated easements.
		Locations where stormwater may be directly discharged into groundwater, such as abandoned wells or sinkholes. Please note if none exists.
		Locations of specific points where stormwater discharge will leave the project site.
		Name of all receiving waters. If the discharge is to a separate municipal storm sewer, identify the name of the municipal operator and the ultimate receiving water.
		Location, size and dimensions of features such as permanent retention or detention facilities, including existing or manmade wetlands, used for the purpose of stormwater management. Include existing or retention or detention facilities that will be maintained enlarged or otherwise altered and new ponds or basins to be built and the basis of their design.
		The estimated depth and amount of storage required by design of the new ponds or basins.
		One or more typical cross sections of all existing and proposed channels or other open drainage facilities carried to a point above the 100-year high water and showing the elevation

		of the existing land and the proposed changes, together with the high water elevations expected from the 100-year storm under the controlled conditions called for by the this ordinance, and the relationship of structures, streets, and other facilities.

4. Stormwater Drainage Technical Report

	A summary report, including the following information:	
		The significant drainage problems associated with the project:
		The analysis procedure used to evaluate these problems and to propose solutions.
		Any assumptions or special conditions associated with the use of these procedures, especially the hydrologic or hydraulic methods;
		The proposed design of the drainage control system; and
		The results of the analysis of the proposed drainage control system showing that it does solve the project's drainage problems. Any hydrologic or hydraulic calculations or modeling results must be adequately cited and described in the summary description. If hydrologic or hydraulic models are used, the input and output files for all necessary runs must be included in the appendices. A map showing any drainage area subdivisions used in the analysis must accompany the report.

	A Hydrologic/Hydraulic Analysis, consistent with the methodologies and calculation included in the (technical standards), and including the flowing information	
		A hydraulic report detailing existing and proposed drainage patterns on the subject site. The report should include a description of present land use and proposed land use. Any off-site drainage entering the site should be addressed as well. This report should be comprehensive and detail all of the steps the engineer took during the deign process.
		All hydrologic and hydraulic computations should be included in the submittal. These calculations should include, but are not limited to: runoff curve numbers and runoff coefficients, runoff calculations, stage-discharge relationships, times-of-concentration and storage volumes.
		Copies of all computer runs. These computer runs should include both the input and the outputs. Electronic copies of the computer runs with input files will expedite the review process and is required to be submitted.
		A set of exhibits should be included showing the drainage sub-areas and a schematic detailing of how the computer models were set up.
		A conclusion which summarizes the hydraulic design and details how this design satisfies the Ordinance.

5. Stormwater Pollution Prevention Plan for Construction Sites

	Location, dimensions, detailed specifications, and construction details of all temporary and permanent stromwater quality measures.	
	Temporary stabilization plans and sequence of implementation.	
	Permanent stabilization plans and sequence of implementation.	
	Temporary and permanent stabilization plans shall include the following:	
		Specification and application rates for soil amendments and seed mixtures.
		The type and application rate for anchored mulch.
	Construction sequence describing the relationship between implementation of stormwater quality measures and stages of construction activities.	
	A typical erosion and sediment control plan for individual lot development.	
	Self-monitoring program including plan and procedures	
	A description of potential pollutant sources associated with the construction activities, which may reasonably be expected to add a significant amount of pollutants to stormwater discharges.	
	Material handling and storage associated with construction activity shall meet the spill prevention and spill response requirements in 327 IAC 2-6.1.	
	Name, address, telephone number, and list of qualifications of the trained individual in charge of the mandatory stormwater pollution prevention self-monitoring program for the project site.	

6. Post-Construction Storm Water Pollution Plan	
	A description of potential pollutant sources from the proposed land use, which may reasonably be expected to add a significant amount of pollutants to stormwater discharges.
	Location, dimensions, detailed specifications, and construction details of all post-construction stormwater quality measures.
	A description of measures that will be installed to control pollutants in stormwater discharges that will occur after construction activities have been completed. Such practices include infiltration of run-off, flow reduction by use of open vegetated swales and natural depressions, buffer strip and riparian zone preservation, filter strip creation, minimization of land disturbance and surface imperviousness, maximization of open space, and stormwater retention and detention ponds.
	A sequence describing when each post-construction stormwater quality measure will be installed.
	Stormwater quality measures that will remove or minimize pollutants from stormwater run-off.
	Stormwaater quality measures that will be implemented to prevent or minimize adverse impacts to stream and riparian habitat.
	A narrative description of the maintenance guidelines for all post-construction stormwater quality measures to facilitate their proper long term function. This narrative description shall be made available to future parties who will assume responsibility for the operation and maintenance of the post-construction stormwater quality measures.

CONSTRUCTION SITE INSPECTION AND MAINTENANCE LOG

(TO BE COMPLETED BY PROPERTY OWNER OR AGENT)

All stormwater pollution prevention BMPs shall be inspected and maintained as needed to ensure continued performance of their intended function during construction and shall continue until the entire site has been stabilized and a **"NOTICE OF TERMINATION"** has been issued. An inspection of the project site must be completed by the end of the next business day following each measurable storm event and/or at least one time per week. Maintenance and repairs shall be completed in accordance with the approved site construction plans. This log shall be kept as a **"Permanent Record"** and shall be made available to the Madison County Drainage Board or their designated representative, in an organized presentable condition within 48 hours upon request.

(yes, no, n/a)

________1. Are all sediment barriers, inlet protection, and silt fences in place and functioning properly?
________2. Are all erodible slopes protected from erosion through the implementation of acceptable soil stabilization practices?
________3. Are all de-watering structures functioning properly?
________4. Are all discharge points free of any noticeable pollutant discharges?
________5. Are all discharge points free of any noticeable erosion or sediment transport?
________6. Are designated "equipment washout areas" properly sited, clearly marked and being utilized?
________7. Are construction staging and parking areas restricted to areas designated as such on the plans?
________8. Are temporary soil stockpiles in approved areas and properly protected?
________9. Are constructed entrances properly installed and being used and maintained?
________10. Are "Do Not Disturb" areas designated by the plans clearly marked on the site and being avoided?
________11. Are public roads at intersections with site access roads being kept clear of sediment, debris and mud?
________12. Is spill response equipment on site, logically located, and easily accessed in an emergency?
________13. Are emergency response procedures and contact information clearly posted?
________14. Is solid waste properly contained?
________15. Is a stable access provided to the solid waste storage and pick-up areas?
________16. Are hazardous materials, and waste being properly handled and stored?
________17. Have previously listed recommended corrective actions been implemented?

If you answered no to any of the above questions, describe any corrective action which must be taken to remedy the problem and when the corrective actions are to be completed.

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Project:______________________________ Permit Number:______________________________

Address:______________________________ Inspected By:______________________________

______________________________ Date:______________________________

CERTIFICATION OF COMPLETION AND COMPLIANCE

MADISON COUNTY DRAINAGE BOARD
MADISON COUNTY INDIANA

Name of Project: ______________________________

Address where land alteration was performed: ______________________________
____

Drainage Permit Number: ______________ Drainage Permit Date: ______________

Plans Prepared By: ______________________________ Date: ______________

Inspection Dates: __________ __________ __________

__________ __________ __________ __________

I hereby certify that:

1. I am familiar with the requirements of the Madison County Drainage Ordinance and Technical Standards of the Madison County Drainage Board as they apply to this land alteration and:
2. I, or a person under my direct supervision, have personally inspected the completed work, examined the drainage permit conditions, and as-built plans (if required) pursuant to the requirements of the approved plans and permit and:
3. To the best of my knowledge, belief, and information provided, the said land alteration has been performed and completed in conformity with the permit requirements except as noted; ______________________________
____
____

Signature: ______________________________ Date: ______________

Printed Name: ______________________________ Phone: ______________

Address: ______________________________

____

(Seal)

SURVEYOR ______________ ENGINEER ______________

Indiana Registration Number ______________________________

NOTICE OF TERMINATION INSPECTION

MADISON COUNTY DRAINAGE BOARD
MADISON COUNTY INDIANA

All land alteration (construction) sites shall be subject to a **"FINAL INSPECTION"** by the **MADISON COUNTY DRAINAGE BOARD** or their designated representative. This inspection shall occur following the project owner or applicant's submittal of the "**Rule 5" NOT, "NOTICE OF TERMINATION"** and is to insure that the site is stabilized and that **"POST CONSTRUCTION BMPs"** have been properly installed.

(To be completed by Madison County Drainage Board or their designated representative)

The inspection shall address the following: (YES, NO, N/A)

______1. Have all earth disturbing activities been completed?
______2. Are all soils stabilized with either vegetation or mulch?
______3. Are all drainageways stabilized with either vegetation, rip rap, or other armament?
______4. Have all temporary erosion and sediment control measures been removed?
______5. Has all construction waste, trash, and debris been removed from the site?
______6. Have all permanent storm water quality BMPs been installed in accordance with the plans, specifications, details and requirements of the storm water permit?
______7. Are all permanent BMPs free of sediment accumulation resulting from construction activities?

If you answered "NO" to any of the above questions, describe any corrective action(s) which must be taken to remedy the problem and when the corrective actions are to be completed.

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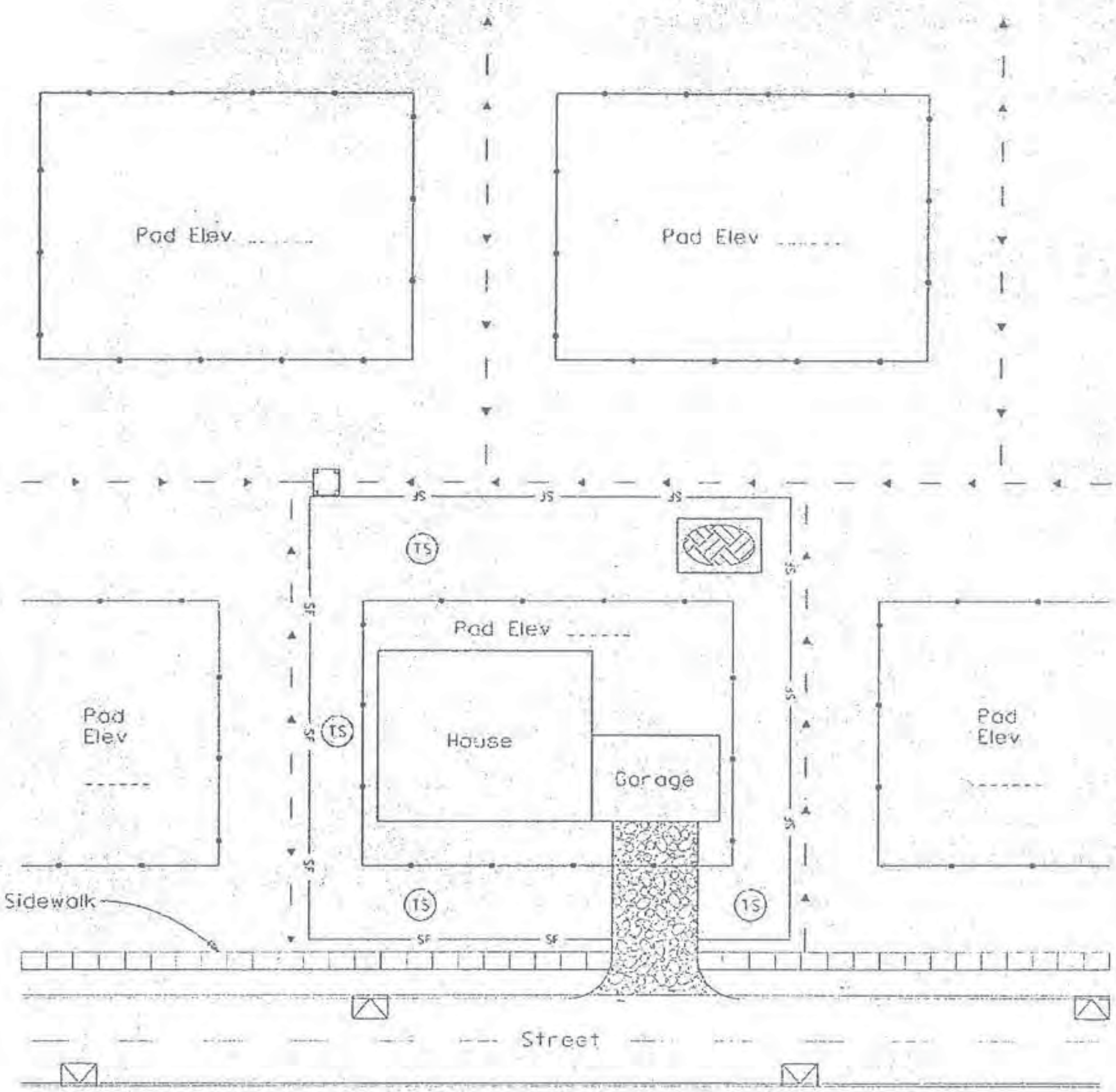
Name of Project:____

Drainage Permit Number:________________ Drainage Permit Date:_____________

Inspected By:__________________________________ Date:_____________



Legend and Check List

—SF—	Silt Fence	☐
	Gravel Construction Entrance	☐
	Drop Inlet Protection	☐
	Curb Inlet Protection	☐
(TS)	Temporary Seeding	☐
	Property Lines / Drainage Swale	☐
	Constructed Building Pad	☐
	Soil Stockpile Protection	☐

Notes:

- Draw in any 'Do Not Disturb' areas.
- Provide pad elevations for subject property and adjacent properties.
- Erosion Control Measures must be functional and maintained throughout construction.

I hereby certify that the drainage ways, pad elevations, and erosion and sediment control measures are consistant with the overall development plans.

APPLICATION
FOR CONNECTION TO REGULATED DRAIN

Applicant Name:________________________________
Printed
Applicant Address:________________________________
____

Telephone:______________ **Cell:**______________

Name of Regulated Drain for proposed connection:________________________
____

Will connection be made to an Open Regulated Drain? Yes:________ **No:**________

Will connection be made to a Tiled Regulated Drain? Yes:________ **No:**________

Location of proposed connection:(nearest road intersection)________________
____

and located in Section: ______, Township:________, Range:______ in ________
________________________ Township.

For a Proposed "New Open Drain" Connection, a "stormwater permit application" must be made.

For a Proposed "New Tile Installation" Connection:

1. Will proposed new tile be draining water from outside "watershed area" of above listed Regulated Drain? Yes:________ **No:**________

2. If yes, list name of Regulated Drain Watershed being drained by proposed new tile:________________________

3. If applicable, diameter and type of tile material of existing regulated drain where connection is to be made:________________________

4. Diameter and type of pipe to be used for proposed new connection:________
____

5. Length of proposed new tile installation:________________

6. Area in acres to be drained by proposed new tile installation:__________

Applicant Signature:________________________ **Date:**____________

Drainage Board Conditions:________________________________
____
____
____

Permit Fee Paid: Yes:________ **No:**________

Drainage Board Approval; Yes:________ **No:**________

Drainage Board President:________________________ **Date:**____________

POST CONSTRUCTION BMP INSPECTION CHECKLIST

BIORETENTION

MADISON COUNTY DRAINAGE BOARD

MADISON COUNTY INDIANA

OPERATION, MAINTENANCE, AND MANAGEMENT CHECKLIST

Project: ______________________________

Location: ______________________________

Date: ____________________ **Time:** ____________________

Inspector: ____________________ **Title:** ____________________

Signature: ______________________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Bioretention and contributing areas clean of debris (litter, branches, etc.)		
No dumping of yard wastes into BMP		
2. Vegetation		
Plant height not less than design water depth but not greater than 6 inches		
Observed plant types consistent with accepted plans		
Plants covering greater than 85% of total BMP surface area		
Plant community appears thick and healthy		
No evidence of erosion		
3. Sediment Deposits/Accumulation		
No evidence of sediment buildup around check dams or energy dissipaters.		
Sumps are not more than 50% full of sediment		
Sediment is not >20% of BMP design depth.		

BIORETENTION

4. Filter Bed		
Dewaters between storms		
Filter bed is not blocked or filled inappropriately.		
5. Outlet/Overflow Spillway		
Good Condition, no need for repair		
No evidence of erosion or downstream scour.		
Outlets are free of blockages.		

Actions to be Taken:

POST CONSTRUCTION BMP INSPECTION CHECKLIST

DETENTION POND

MADISON COUNTY DRAINAGE BOARD

MADISON COUNTY INDIANA

OPERATION MAINTENANCE AND MANAGEMENT CHECKLIST

Project: ______________________________

Location: ______________________________

Date: ____________________ Time: ____________

Inspector: ____________________ Title: ____________

Signature: ______________________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Embankment and emergency spillway		
Healthy vegetation with at least 85% ground cover.		
No signs of erosion on embankment.		
No animal burrows.		
Embankment is free of cracking, bulging, or sliding.		
Embankment is free of woody vegetation.		
Embankment is free of leaks or seeps		
Emergency spillway is clear of obstructions.		
Vertical/horizontal alignment of top of dam "As-Built"		
2. Riser and principal spillway		
Low flow outlet free of obstruction.		
Trash rack is not blocked or damaged.		
Riser is free of excessive sediment buildup		
Outlet pipe is in good condition.		
Control valve is operational		
Outfall channels are stable and free of scouring.		

POST CONSTRUCTION BMP INSPECTION CHECKLIST

DETENTION POND

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
3. Permanent Pool (Wet Ponds)		
No Evidence of undesirable vegetation		
No accumulation of floating or floatable debris		
No evidence of shoreline scour or erosion		
4. Sediment Forebays		
Sediment is being collected by forebay(s)		
Forebay is not in need of cleanout (less than 50% full)		
5. Dry Pond Areas		
Healthy vegetation with at least 85% ground cover.		
No undesirable woody vegetation		
Low flow channels clear of obstructions		
No evidence of sediment and/or trash accumulation		
6. Condition of Outfall into Ponds		
No riprap failures		
No evidence of slope erosion or scouring		
Storm drain pipes are in good condition, with no evidence of non-stormwater discharges		
Endwalls/Headwalls are in good condition		

POST CONSTRUCTION BMP INSPECTION CHECKLIST

FILTER STRIP

MADISON COUNTY DRAINAGE BOARD **MADISON COUNTY INDIANA**

OPERATION MAINTENANCE AND MANAGEMENT CHECKLIST

Project: ______________________________

Location: ______________________________

Date: ____________________ Time: ____________________

Inspector: ____________________ Title: ____________________

Signature: ______________________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Vegetation		
Observed plant types consistent with accepted plans		
Vegetation is healthy		
Plants covering greater than 85% of total BMP surface area		
Grass height not more than 6 inches		
No evidence of concentrated flows		
No evidence of erosion		
2. Level Spreader		
Lip of spreader showing no signs of erosion		
Sediment noted in spreader?		

Actions to be Taken: ______________________________

POST CONSTRUCTION BMP INSPECTION CHECKLIST **INFILTRATION BASIN**

MADISON COUNTY DRAINAGE BOARD **MADISON COUNTY INDIANA**

OPERATION MAINTENANCE AND MANAGEMENT CHECKLIST

Project: ______________________________

Location: ______________________________

Date: ____________________ Time: ____________________

Inspector: ____________________ Title: ____________________

Signature: ______________________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Basin bottom clear of debris		
Inlet clear of debris		
Outlet clear of debris		
Emergency spillway clear of debris		
2. Sediment Traps or Forebays		
Obviously trapping sediment		
Greater than 50% of storage volume remaining		
3. Vegetation		
Mowing done when needed		
No evidence of erosion		
4. Dewatering		
Basin dewatered between storms		

INFILTRATION BASIN

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
5. Sediment Cleanout of Basin		
No evidence of sedimentation		
Sediment accumulation does not yet require cleanout		
6. Inlets		
Good condition		
No evidence of erosion		
7. Outlets/Overflow Spillway		
Good condition, no need for repair		
No evidence of erosion		
8. Structural Repairs		
Embankment in good repair		
Side slopes are stable		
No evidence of erosion		
9. Fences/Access Repairs		
Fences in good condition		
No damage which would allow undesirable entry		
Lock and gate function adequate		
Access point in good condition		

Actions to be Taken:____

POST CONSTRUCTION BMP INSPECTION CHECKLIST **INFILTRATION TRENCH**

MADISON COUNTY DRAINAGE BOARD **MADISON COUNTY INDIANA**

OPERATION MAINTENANCE AND MANAGEMENT CHECKLIST

Project: ______________________________

Location: ______________________________

Date: ______________ Time: ______________

Inspector: ______________ Title: ______________

Signature: ______________________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Trench surface clear of debris		
Inflow pipes clear of debris		
Overflow spillway clear of debris		
Inlet area clear of debris		
2. Sediment Traps or Forebays		
Obviously trapping sediment		
Greater than 50% of storage volume remaining		
3. Trench		
Trench dewaters between storms		
No evidence of sedimentation in trench		
Sediment accumulation doesn't yet require cleanout		
4. Inlets		
Good condition		
No evidence of erosion		

POST CONSTRUCTION BMP INSPECTION CHECKLIST **INFILTRATION TRENCH**

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
5. Outlet/Overflow Spillway		
Good condition, no need for repair		
No evidence of erosion		
6. Aggregate Repairs		
Surface of aggregate clean		
Top layer of stone does not need replacement		
Trench does not need rehabilitation		

Actions to be Taken:________________________________

POST CONSTRUCTION BMP INSPECTION CHECKLIST

MEDIA FILTRATION

MADISON COUNTY DRAINAGE BOARD

MADISON COUNTY INDIANA

OPERATION MAINTENANCE AND MANAGEMENT CHECKLIST

Project: ____________________

Location: ____________________

Date: ____________________ Time: ____________________

Inspector: ____________________ Title: ____________________

Signature: ____________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Contributing areas clean of debris		
Filtration facility clean of debris		
Inlet and outlets clear of debris		
2. Oil and Grease		
No evidence of filter surface clogging		
Activities in drainage area minimize oil and grease entry		
3. Vegetation		
Contributing drainage area stabilized		
No evidence of erosion		
Area mowed and clippings removed		
4. Water Retention Where Required		
Water holding chambers at normal pool		
No evidence of leakage		

Actions to be Taken: ____________________

POST CONSTRUCTION BMP INSPECTION CHECKLIST

VEGETATED SWALE

MADISON COUNTY DRAINAGE BOARD

MADISON COUNTY INDIANA

OPERATION MAINTENANCE AND MANAGEMENT CHECKLIST

Project: ______________________________

Location: ______________________________

Date: ____________________ **Time:** ____________________

Inspector: ____________________ **Title:** ____________________

Signature: ______________________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Contributing drainage areas free from debris		
2. Vegetation		
Mowing performed when needed		
No evidence of erosion		
3. Check Dams or Energy Dissipaters		
No evidence of flow going around structure		
No evidence of erosion at the downstream toe		
Soil permeability		
4. Sediment Forebay		
Sediment cleanout not needed (clean out when 50% full)		

Actions to be Taken: ______________________________

POST CONSTRUCTION BMP INSPECTION CHECKLIST

WETLAND

MADISON COUNTY DRAINAGE BOARD

MADISON COUNTY INDIANA

OPERATION, MAINTENANCE, AND MANAGEMENT CHECKLIST

Project: ______________________________

Location: ______________________________

Date: ______________________ Time: ______________

Inspector: ______________________ Title: ______________

Signature: ______________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Embankment and Emergency Spillway		
Healthy vegetation with at least 85% ground cover.		
No signs of erosion on embankment.		
No animal burrows.		
Embankment is free of cracking, bulging, or sliding.		
Embankment is free of woody vegetation.		
Embankment is free of leaks or seeps		
Emergency spillway is clear of obstructions.		
2. Riser and Principal Spillway		
Low flow outlet free of obstruction.		
Trash rack is not blocked or damaged.		
Riser is free of excessive sediment buildup		
Outlet pipe is in good condition.		

Control valve is operational		
Outfall channels are stable and free of scouring.		
3. Wetland		
Plants covering greater than 85% of total wetland surface area (excluding open water areas)		
Observed plant types consistent with accepted plans		
No evidence of excessive sediment accumulation in wetland area		
Water depths consistent with accepted plans		
No evidence of erosion on banks.		
Wetland areas clean of debris (litter, branches, etc.)		
No evidence of dumping of yard wastes into BMP		
4. Forebay		
Sediment is being collected by forebay(s)		
Forebay is not in need of cleanout (less than 50% full)		

Actions to be Taken: ______________________________